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Natriumweg 7, Amersfoort, pp. 1-80,
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A N N U A L R E P O R T

1973

Institute for Waste Removal (SVA)
Natriumweg 7, Amersfoort,
Post Office Box 184,
Telephone: 033-12904

submitted by the director and ratified by the board of directors in November 1974.

Members of the Board

chairman: R. Dijkshoorn+, eng.,appointed by the Minister of Health and Environmental Hygiene

secretary: R. van Poelje, lawyer, appointed by the Minister of Health and Environmental Hygiene

H. J. A. Schaap, lawyer, appointed by the Minister of Health and Environmental Hygiene

J. de Coole, appointed by the Minister of Agriculture and Fisheries

Drs. B. J. M. Giesen, appointed by the Minister of Economic Affairs

Dr. N. J. A. Groen, appointed by the Minister of Health and Environmental Hygiene

G. Jansen, appointed by the Minister of Internal Affairs

Drs. P. Velde, appointed by the Minister of Finance

K. C. Zijlstra, eng., appointed by the Minister of Highways and Waterways (amendment of the statutes is pending)

Members of the Operating Committee

chairman: A. A. Beckeringh van Rhijn, appointed by the Board of Netherlands Municipalities

vice-chairman: J. V. Duym, appointed by the Council of Employers in the Netherlands

secretary: Mr. R. van Poelje, appointed by the Minister of Health and Public Hygiene

Ir. H. Bijker, eng., representative of the Provinces, appointed by the Minister of Internal Affairs

Ir. J. Hellemans, eng., (sub.), appointed by the Council of Employers in the Netherlands

H. van der Horst, appointed by the Board of Netherlands Municipalities

Ir. T. Krijgsman, eng., appointed by the Netherlands Board of Cleansing Directors

W. M. Broeders, appointed by the Agricultural Board

Ir. A. M. Pingen, appointed by the Netherlands Board of Cleansing Directors

Ir. J. P. Planje, eng., appointed by the Agricultural Board

Drs. K. Vellema, appointed by the Minister of Housing and Development

L. Verweij (sub.), appointed by the Board of Netherlands Municipalities

Ir. J. E. Waterman, eng., appointed by the Council of Employers in the Netherlands

Ir. W. K. Barentsen, eng., appointed by the Minister of Highways and Waterways

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Chapter 1

General

1. Personnel

Miss A. A. Holtman retired as secretary on 1 April for marriage. On 24 April Miss W. Muijs was hired as replacement. On 1 August G. Den Hollander joined the administrative office as administrative assistant. Mr. Den Hollander will carry out activities in the offset and publication reproduction area, and he will assist in the library and in the filing office.

Four vacancies were filled in the technological division. On 1 May T. Boerefijn was hired as draftsman/designer. On 1 July P. S. Baayens, eng., was hired as consulting engineer, and on the same date W. Kroonder commenced his activities as chief technical officer. Mr. Kroonder is charged with the evaluation and the checking of of the architectural data of the processing installations. On 1 September W. A. J. Levolger, eng., was hired as technical officer. Mr. Levolger will carry out data collection at the concerns and will check and evaluate the specifications at the technical installations, where he will also collect data on performance.

A project group in chemical technology was formed in the course of the year. The head of it -- F. van Veen, eng. -- will co-ordinate all activities of the SVA with special concern on the removal of waste materials which are difficult to process -- chemicals.

In the economic-legal division, Drs. J. M. Joosten was hired on 1 July and M. Houwers on 1 September. Mr. Joosten is an economist who will study cyclic processes; Mr. Houwere is an administrative officer who will collect and record raw data as well as carrying out analyses on the collection and transporting of waste materials.

In 1972 a few chemists were hired on a temporary basis as part of the Project for Supplementary Employment for Unemployed Chemists--operated by the Ministry of Social Affairs. Six-month periods of employment were offered to Miss L. E. van Engers, eng., on 1 March and to Drs. G. J. Alsema and M. Verhoef on 1 April. Miss van Engers carried out experiments on physical and chemical processes in the soil, which would have some effect on ground water pollution at dumping sites. Her investigations included microbe processes in the soil and dumping sites as well. Mr. Alsema studied waste materials which contain inorganic compounds; this was done in connection with the project on existing processing possibilities and on processing possibilities yet to be developed. He studied as well the possible emissions that can occur during processing.

Mr. Verhoef was hired as analyst.
The orginal employment contract for 6 months was extended in the course of the year for an additional 6 months.

During the time period 1 August - 21 October 1973, Mr. C. P. N. van Rijn worked with the SVA as volunteer. Mr. Van Rijn, under instructions from the Agricultural College in Wageningen, carried out a literature search on the technical phenomena that can occur in the soil resulting from the dumping of wastes.

All staff positions were filled at the end of the year. On 31 December the personnel register was as follows:

director:	Ir. T. Teeuwen, eng.
Technological Division	
head (acting director):	Ir. B. G. Kreiter, eng.
Consultants	
consulting engineer:	Ing. N. Th. Hummelen
consulting engineer:	Ir. W. J. Ludikhuize
consulting engineer:	Ir. P. S. Baayens
Chemical Technology	
head:	Ir. F. van Veen
technical chemist:	Ing. P. J. Meijer
Drafting Office	
head:	Ing. J. J. Vos
draftsman/designer:	F. Ochse
draftsman/designer:	T. Boerefijn
draftsman/designer:	A. H. van Keken
Research and Testing - including visits to concerns	
head:	J. J. Sluijmers
civil engineer:	Ing. W. Kroonder
mechanical engineer:	Ing. W. A. J. Levolger
operator/measurement technician	A. A. J. Cornelissen

Economic-Legal Division

head:	Ir. J. A. van der Kuil
lawyer:	Mr. P. Schreuder
economist:	Drs. J. M. Joosten
engineer:	Ir. G. van Bezooyen
statistical assistant:	L. van Vliet
analyst:	M. Houwers

Technical Division for Soils

head:	Ir. E. J. Mesu
biochemist:*	Miss Ir. L. E. van Engers
senior agriculturalist:	Ing. C. T. Beunder
agriculturalist:	W. G. Martens

Division for Chemical Research

head:	Dr. I. H. Anthonissen
analyst:	P. E. Boersma

Administrative Division

head:	K. P. Bijleveld
secretary:	Mrs. J. M. Potijk-van der Helm
secretary:	Mrs. W. Lustic-Muijs
assistant bookkeeper:	H. C. W. Ketelaar
copier:	H. J. Schoenaker
switchboard/typist:	Mrs. C. Nieuwenhuis-Harderman
administrative officer:	G. den Hollander

*At the end of the year permission was obtained to offer to Miss Ir. L. E. van Engers a permanent position in 1974.

2. Library and Reading Room

The library has been expanded with additional books, lectures, folders and other kinds of literature in the field; an additional journal was subscribed to. Interest in the various research projects of the Institute increased; this was achieved partly by the publicity in the press. As a result there was an increasing demand for SVA publications. At the present time publications on 35 topics are available. We provided an appendix for the Bowal-pool.

3. Space

At the beginning of the year all the available space was in use. We have consulted with representatives of the various ministries about the possibilities of additional space. At the end of the year discussions were at the stage that we can expect around the first of 1974 a definite decision on the future space for the SVA.

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CHAPTER II

ACTIVITIES

1. Counseiling

1.1 Directorate-General for Environmental Hygiene

Recommendations were made to the Directorate-General for Environmental Hygiene of the Ministry of Public Health and Environmental Hygiene. The recommendations concerned the following: re-cycling possibilities for paper, glass and tin, the removal of wastes, where special attention was given to the problem of chemical wastes.

1.2 Flax Bags

On request from the Directorate-General for Environmental Hygiene, recommendations were made on the use of a bag constructed from flax for the storage, collecting and processing of household refuse. It concerned a process, discovered by a plant in Zeeuws-Vlaanderen, whereby a non-woven membrane was constructed from flax and from which garbage bags were made. To obtain an insight into its usability, the SVA instructed the Packing Institute TNO (Instituut voor Verpakking TNO) to test the flax garbage bag in a laboratory scale project. The SVA itself organized a test in Nijmegen, one in actual use of the bag, whereby the decomposition of this flax garbage bag was investigated in the Dano system of composting (at Soest-Baarn) and in the Van Maanen system (in Nierlo). A report has been prepared by the CIVI for the Minister of Economic Affairs on the costing of the flax bag and the economic consequences for flax cultivation.

1.3 Regulation of the Transport of Household Refuse by Ships (Regeling Huisvuil Scheepvaart)

On instructions from the Directorate-General for Environmental Hygiene, a start was made on the re-writing of the temporary regulations, based on a recommendation prepared by the Committee on The Regulation of the Transport of Household Refuse by Ships (Commissie Regeling Huisvuil Scheepvaart), into a definite form. For this purpose, an interim report was made to the Directorate-General and supplementary proposals for the definitive regulation were included in it.

1.4 Draft Bill on Packaging Materials

The proposers of the bill on Packaging Materials -- members of the Lower House (Tweede Kamer), Mrs. drs. Epema-Brugman and Dr. Terlouw -- requested the director of the SVA for comment. The opinion of the SVA was prepared in the form of a note which was submitted to the Minister of Public Health and Environmental Hygiene who in turn directed it to the secretary of the Labor party faction (Partij van de Arbeid) in the Lower House.

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1.5 "Returnable Deposit" Scheme for Junked Cars

The SVA sent factual information to the interdepartmental ad-hoc working group, that was charged with developing a "returnable deposit" scheme for new cars.

1.6 Arnhem Region (Gewest)

Recommendations and evaluations of drawings and specifications on important segments of the facility constituted the activities of this group. The SVA nominated J. J. Sluijmers to be consultant-member of the building commission. The first pile of the facility was struck by Drs. H. F. Louwe Kooymans, inspector of public health, whose duties are to control the environmental hygiene quality in the province of Gelderland. Progress of construction is going according to plan; the installation can be brought on stream in 1975.

1.7 Metro Region (Stadsgewest) 's Hertogenbosch

At the end of 1972 the Metro Council (Gewestelijke Raad) of 's Hertogenbosch decided to treat its refuse by controlled dumping. They asked the Refuse Board (Vuilbank) for advice on the expansion of the present dumping site as well as on the plan for the establishment of one or more regional dumping sites. The SVA was represented in the group that led the whole project. The group has met several times and concerned itself mostly with factors which determine the choice of dumping sites. At the end of the year a definitive report was presented to the Vuilbank.

1.8 Central Refuse Processing Facility in IJmond (Centraal Afvalverwerkingsbedrijf IJmond) (CAY)

On 30 October 1972 the Institute for Waste Removal (SVA) was requested by the Central Refuse Processing Facility in IJmond for recommendations on waste removal questions in the participating communities (Beverwijk, Castricum, Heemskerk, Uitgeest and Velsen). In the recommendation attention was given to the areas of this region tangential with those of the adjoining regions, Zaanstreek and Zuid-Kennemerland, as well as on the following possibilities for refuse processing:

- controlled dumping of all kinds of wastes;
- pulverization of a portion of the wastes and afterwards its controlled dumping;
- decomposition of a portion of the waste in the region;
- compacting of a portion of the waste followed by controlled dumping;
- combustion of combustible waste, and the dumping of non-combustible waste and residues at controlled dumping sites;
- transporting away of a portion of the waste by VAM.

The Council (Dagelijks Bestuur) of this region decided after extensive deliberations to establish a combustion facility for wastes. The SVA was brought into the process of requesting and evaluating tenders and for consulting activities during the construction of the facility. Several meetings of the Technical Commission of the

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Central Refuse Processing Facility (CAY) were also attended in connection with the expansion of the existing dumping site in Beverwijk. A plan was prepared for the dumping activities of a contractor, authorized by the CAY to dump there.

1.9 Development Board in Zaanstreek (Ontwikkelingsschap Zaanstreek)

The tenders, received at the end of 1972, were evaluated, so that the Development Board in Zaanstreek could bring out a recommendation of the type of refuse combustion facility to be chosen. After modifying a few procedures because of implications of the Nuisance Act, the Air Pollution Act and of the plant's location, the Development Board will be able to proceed with the construction of a combustion facility for the region before the end of the year. After joint deliberation, an agreement was reached on the delivery of the facility. Several discussions were held with B&W (the municipal council) of Assendelft, the technical commission of the Development Board and with representatives of the "Assendelver Veenpolder Study Group" on the proposed dumping site for solid wastes in the Assendelver Veenpolder. The study group objected to the proposed location of the dumping site. A public meeting was held in Assendelft on this question; the SVA provided technical information for the meeting.

1.10 Midden Utrecht Group (Kring Midden Utrecht)

By letter on 26 January 1973, the Board of the Midden Utrecht Group requested the SVA to prepare a report on a processing facility for refuse. The following aspects were treated in the report on this facility:

- the capacity;
- the investment in and the cost of running the facility;
- the use of the heat generated by the combustion of refuse;
- the possibility of re-cycling refuse.

The report was prepared in June.

On 1 September 1973 a number of municipalities in the region formed a legal entity called "Refuse Processing - Midden Utrecht" (Vuilverwerking Midden Utrecht). The task of this organ is the founding and operation of a refuse combustion facility and of a dumping site for non-combustible refuse. The following activities were carried out by the SVA on bringing into being the refuse combustion facility:

- Discussion concerning the siting;
- application of procedures in accordance with the Air Pollution Act and the Nuisance Act;
- creation of a definite set of requisites for the facility.

1.11 Midden-Holland-Rijnstreek Region

On 4 June the Technical Working Group for Refuse Combustion in Midden-Holland-Rijnstreek requested the SVA to prepare an interim report which would deal with the following aspects:

- a set of general requisites that a combustion facility, yet to be constructed, should satisfy;
- the amount of combustible refuse that can be expected using as much recent data as possible;
- the determination of the capacity of the facility;
- the economic aspects of combustion with and without the use of the heat produced, (i.e. the generation or not of electrical energy).

After the report was prepared, it was decided, in principle, to carry out the combustion of urban refuse and combustible industrial waste at another site, yet to be determined, in the region. In order to bring this combined facility into being, activities have been carried out on:

- consultation as far as siting is concerned,
- application of procedures in accordance with the Air Pollution Act and the Nuisance Act;
- the creation of a set of requisites for the facility.

1.12 Hoogheenraadschap (Hoogheem Board) on the Sluices Draining Kennemerland and West-Friesland

On 14 March the above-named board requested the SVA to carry out an investigation of the processing methods for purification mud, generated at the sewage water purification facility in Beverwijk. Processing methods, such as controlled dumping and combustion (in combination or not with urban refuse) were considered in the investigation. The report was finished in the course of the year..

1.13 Noord-West Veluwe Region (Gewest)

As a supplement to the SVA report, appearing in 1972, on this region, further information was given on the possibility of bringing into being a controlled refuse dumping site in a sand pit in the "Ullergerg" area near Ermelo. At the same time, the owners of the area were informed of the situation. Advice was given that a study should be commissioned on the northerly area of the region to obtain information on the possibilities of a second or alternative dumping site, or an alternative location.

1.14 Twente Board (Twenteraad)

The Council (Dagelijks Bestuur) of the Twente Board, in October, requested collaboration on the preparation of a report, "Report on Refuse Processing in Twente" (Rapport Vuilverwerking Twente) to be submitted by the Commission on Refuse Processing

of the Twente Board. This report will contain a number of alternative methods for refuse processing and will be completed in mid-January 1974.

1.15 Noord-Holland (North Holland)

On 5 June, the Provincial Council (Provinciaal Bestuur) of Noord-Holland requested an overview on waste processing in the following regions:

- IJmond;
- Zuid Kennemerland;
- Zaanstreek;
- Amsterdam.

In the review, the following aspects will be dealt with:

- the possibility of co-operation among the regions named;
- the re-cycling of wastes;
- the use of the heat released in combustion. In particular, one will treat here the generation of electrical energy and the joint operation of energy generation with heat production for de-salination processes.

The report will be published in mid-March 1974.

1.16 Miscellaneous Activities

Written and oral recommendations were given to a number of municipalities and facilities. These included:

- The Soil Science Institute of the State University of Utrecht - dr. ir. J. J. Reijnders - concerning ground water pollution at Stikke Trui.
- The Public Board on Waste Processing in Twente (Openbaar Lichaam Vuilverwerking Twente) - about a note prepared by the Public Board on possible pollution in the area resulting from the dumping site in Delden.
- the Oostelijke Mijnstreek region (stadsgewest) and the Noord-Groningen region (Usquert and vicinity) - on the requirements to be put on controlled dumping.
- the municipalities Bergen (in Limburg) and Lopik - on possible ground water pollution resulting from a dumping site.
- the province of Gelderland - on the organization of the collection of partially used pesticides and their containers.
- the federal service for IJsselmeer polders (Rijksdienst IJsselmeerpolders) - on directives that must be observed for controlled dumping and the methods for deciding the site.
- the municipality Helmond - on the establishment of the dumping site.
- the municipality Oss - discussions on the amount of waste generated and on the procedures to be followed for determining a location for the dumping site.
- the municipalities Zoetermeer and Utrecht - who were advised on sorting in the collection of old paper, cartons and glass.

- consultations to a number of factories on the handling of wastes that are difficult to process.

2. Testing

Guarantee Measurements on the Combustion Facility in Alkmaar

The Public Works Service (Dienst Openbare Werken) of the municipality of Alkmaar requested the SVA to carry out, or have carried out by other parties, measurements on the combustion facility to check if the performance guaranteed by the manufacturer was achieved. During a period of 8 hours the following measurements and others were carried out:

1. hoeveelheid verbrande afvalstoffen	8.500 kg/h
2. vochtigheid van de verbrande afvalstoffen	37,2%
3. relatieve vochtigheid van de verbrandingslucht	55%
4. temperatuur van de verbrandingslucht	10°C
5. hoeveelheid in de ontslakker verbruikt water	430 kg/h
6. temperatuur van het water in de ontslakker	77°C
7. hoeveelheid koellucht	4100 nm³/h
8. relatieve vochtigheid koellucht	40%
9. temperatuur koellucht	16°C
10. hoeveelheid inspuitwater	8.150 kg/h
11. temperatuur inspuitwater	7°C
12. hoeveelheid vaste verbrandingsresten	1702 kg/h
13. vochtgehalte vaste verbrandingsresten	18,1%
14. percentage onverbrand in slak	2,58%
15. oppervlaktetemperatuur van de oven	25°C
16. vuurhaard eindtemperatuur	960°C
17. CO_2-percentage na de koeler	8,9%
18. CO-percentage na de koeler	0%
19. CO_2-percentage na de koeler	11,6%
20. H_2O-gehalte na de koeler	480 g/nm³

1. amount of refuse burned
2. humidity of the refuse burned
3. relative humidity of the combustion gas
4. temperature of the combustion gas
5. amount of water used in the de-slager
6. temperature of the water in the de-slager
7. amount of cooling air
8. relative humidity of the cooling air
9. temperature of the cooling air
10. amount of water injected
11. temperature of water injected
12. amount of solid combustion residues
13. humidity content of the solid combustion residues
14. precentage of non-combustibles in the slag
15. surfact temperature of the oven
16. hearth temperature
17. CO_2 percentage after the cooler (??same as 19??)
18. CO percentage after the cooler
19. CO_2 percentage after the cooler
20. H_2O content after the cooler

Using the weight balance and the heat balance, the combustion coefficient of the refuse can be calculated (Hu = 1850 kcal/kg).

In terms of important properties (heat capacity, slag combustion, flue gas temperature and purification of the flue gas) the facility completely meets the specifications. The means of measuring, the values measured and the control calculations have been presented in a report.

3. Working Groups and Commissions

3.1 Provincial Water Jurisdiction Services Contact Group (Kontaktgroep Provinciale Waterstaatsdiensten)

Meetings were held on 30 January and 3 April with this contact group under the chairmanship of Ir. H. Bijker. Among other topics, discussions at these meetings covered agrarian waste, pesticides, chemical wastes, junked cars, and the hydrasposal fibreclair system for processing and reclaiming refuse. At the meeting on 3 April a representative of the Joint Utrecht Iron Industry (Verenigde Utrechtse IJzerhandel (VUY)), a subsidiary of Hoogovens, gave a talk on the possibilities seen by the VUY for its contribution towards the problem of junked cars.
On June 7 a visit was made to the Rijmond Refuse Processing facility. At the end of the year the contact group was transformed into a provincial group called the interprovincial Technical Discussion Group on Soils and Wastes (Technisch Overleg Bodem en Afvalstoffen) (Iptoba).

3.2 Provincial Planological Services (PPD) Contact Group

This contact group has the following purpose: to develop a viewpoint of the PPD on waste removal from the point of view of a responsible use of space for the purpose of burial of wastes in the ground, with special concern for the national viewpoint.
The group met three times under the direction of drs. F. H. Vogel. The work of this contact group is proceeding constantly. The following aspects of refuse removal have been discussed:

- inventory of the amount of refuse and prognoses;
- necessary burial space in or on the ground related to the method of refuse processing;
- motivation and purpose relating to the planological aspects of waste removal.

3.3 Working Group on a Refuse Structure Scheme (Structuurschema Afvalstoffen)

Activities are proceeding on the development of a structure scheme for refuse, which in part corresponds to the discussions in the Provincial Planological Services Contact Group. Representatives of the Ministry of Public Health and Environmental Hygiene, of the Federal Planological Service and of the SVA are in this working group.

3.4 NVRD Commission for Training and Education

The course, started in October 1972, for the Training of Personnel in Public Cleansing (opleiding Personeel Openbare Reiniging (OPOR)) appears to be a great success. The course was completed with a final examination, on 9 May. The end of the examination which was written under the supervision of the federal examiners, consisted of a case-study. An NVRD diploma was presented to the participants in the course. The Commission for Training and Education decided to give the course on the same basis in October 1973.

3.5 Working Group on Economic Aspects of Environmental Management

Participation in this departmental working group of the Ministry of Public Health and Environmental Hygiene was made in those cases which dealt with the removal of wastes.

3.6 Commission on Junked Cars in Friesland

Further participation was done in the activities of this commission. As part of the activity, a visit was made to a junked auto processing facility in Leer in Germany.

3.7 Contact Group on Pesticide Remainders

In all provinces - with the exception of Zuid-Holland and Zeeland which will join at the start of 1974 - a single drive to collect pesticide remainders was made. A disadvantage for the provinces 2 as was that the collected material could not be directly shipped to the Rijnmond Refuse Processing plant, since the facility was not in operation. As of 1 December shipping became possible. The contact group met several times under the chairmanship of Ir. E. J. Mesu. At the end of the year the contact group prepared a report on the "Removal of Remainders of Mercury-containing Pesticides".

3.8 Working Group on Deep Subterranean Discharge

The working group carried out an investigation on the possibilities of deep subterranean discharges, under the direction of the Study and Information Centre of the TNO. The working group concluded its activities by presenting a report dated July 1973 on "Prospects for subterranean discharge of wastes in the Netherlands".

3.9 Commission on Public Cleansing (Begeleidingskomissie Openbare Reiniging)

The SVA was represented in this commission. The final report was made by the Social Institute for Applied Psychology to the commissioning committee - the former Ministry of Social Affairs and Public Health.

3.10 Collection by Retailers of Separated Paper (Aktie Papier Apart Detaillisten) (Sorted) in Zaandam

The results of the testing period suggested that the test be extended for two six-month periods. Originally, for a few weeks, in the second six-month period, the collecting frequency was changed from once to twice per week. The results were such that, very quickly, it was decided to revert to the once per week collecting frequency. A report on the first period "Test of the Collecting by Retailers of Separated (Sorted) Paper" has been prepared.

3.11 Co-ordinating Commission for the Test Project for the Collection of Sorted Glass Containers

Much data has been collected on the experience gained by local collecting drives. The test project has received a lot of publicity, and public interest. A report, describing the results and the analysis of them, is in preparation.

3.12 Working Group on Re-cycled Tin Cans

The working group consists of representatives from the tin can industry, the metal industry, the scrap trade, the de-tinning industry and the SVA; it has begun its deliberations. Its function is to see how used tin containers from household use can be responsibly re-cycled. In order to study the technical possibilities for the re-cycling of tin, one must first investigate the ways in which used tin containers can be recovered from household refuse. At the end of the year, activities were concentrated on two aspects:

- where is the tin during the various phases of the various processing methods;
- how can the used tin be obtained in an optimal fashion for its re-cycling as iron or even as tin.

An interim report contains the results obtained.

3.13 Legislation on Chemical Wastes

This working group has spent much time preparing for the legislation on chemical wastes, introduced into the Lower House in 1973. Two working subgroups are doing preliminary work on the application of the, yet to be promulgated, General Rules for Control (Algemene Maatregelen van Bestuur). The SVA participates in the activity as advisor.

3.14 Legislation on Wastes

After submission of the draft of the law on chemical wastes, attention was given by the Ministry of Public Health and Environmental Hygiene to the preparation of a general law for wastes. The working group, in which the SVA is represented, meets on the average of once per week.

3.15 Interdepartmental Commission on Wastes (ICA)

The meetings of the Interdepartmental Commission on Wastes, charged with the preparation of the draft law on chemical wastes, were attended by the SVA. As a part of this, Ir. T. Teeuwen attended two joint meetings with the ICMH (the Interdepartmental Commission on Environmental Hygiene).

3.16 Working Group on "Chemical Wastes from the Agricultural College in Wageningen

The inventory of chemical wastes from the institutions coming under the Ministry of Agriculture and Fisheries has been completed. In November 1973 a report titled, "Study of Chemical Wastes" was submitted to the minister concerned. Among other topics the report contained advice on the removal of these wastes.

3.17 Working Group on the Organic Fertilizing of Sporting Fields

During the year this working group, in which besides the SVA, the NSF, KNVB, KNMH and VAM N.V. are represented, watched the progress of the tests on the sporting fields at the river clay site in Altforst and discussions were held several times. An interim report was conceived.

3.18 Working Group on Phenomena associated with Transporting and Storing and their connection with Soil Pollution

Discussions with this working group were attended. This working group, formed because of contacts between associates of the various institutes which are concerned with soil pollution, is aiming to co-ordinate the research efforts in the institutes. The working group is composed of associates of the Agricultural College (Landbouwhogeschool), the Institute for Culture Techniques and Water maintenance (Instituut voor Cultuurtechniek en Waterhuishouding), the Institute for Soil Mapping (Instituut voor Bodemkartering, the Institute for Soil Fertility (Instituut voor Bodemvruchtbaarheid), the Institute for the Application of Atomic Energy to Agriculture (Instituut voor Toepassing van Atoomenergie in de Landbouw), the Laboratory of Insecticide Research (Laboratorium voor Insecticidenonderzoek) and the Institute for Environmental Hygiene and Health Techniques (Instituut voor Milieuhygiene en Gezondheidstechniek) TNO.

3.19 Purification Mud Commission of the Netherlands Union for Waste Water Purification

This commission is busy with studying questions in the field of purification mud processing. At the same time the present methods for treating mud are being investigated. The commission published an article titled, "Methods of Purification Mud Processing", in the journal H_2O in 1973.

3.20 Provincial Purification Mud Commission for Noord-Holland

As part of the discussion on the purification mud processing tests carried out in Westwoud by STORA, several meetings of this purification mud commission were attended. A report was given on the test and proposals were made on the continuation of the test.

3.21 Subcommission on the Re-cycling of Wastes TNO

This commission, under the chairmanship of prof. dr. ir. C. Boelhouwer, is examining: "the study of possibilities for the re-cycling of wastes, formulating further research into the technical, economic and social aspects of this re-cycling, as well as the consideration of production and consumption processes, before the waste phase is reached". Ir. J. A. Kuil participates in the activities of the commission and contributes the information available to the SVA in this field.

3.22 Working Group on Chemical Waste Processing in Moerdijk

This working group was created by the Steering Committee Covenant Moerdijk to advise on the plans submitted by several concerns for the establishment of a combustion facility for the processing of liquid and solid chemical wastes at the industrial site in Moerdijk. The working group will produce a report on the basis of the information abtained from these concerns on the proposed working method and the environmental consequences expected from using the method.

3.23 Black Clawson Commission

On request from the Ministry of Public Health and Environmental Hygiene, Ir. J. A. van der Kuil and drs. J. M. Joosten contributed, as advisors, to the activities of this commission; the task of the commission is to formulate an opinion on the possibility of establishing an installation which can reclaim, using a wet sorting procedure, useful components from the household refuse at the site of the VAM, N. V. in Wijster. The report was almost finished at the end of the year.

3.24 Interprovincial Commission on Chemical Wastes

Ir. T. Teeuwen sits on this commission, created by the three northerly provinces, as advisor. The report titled, "Investigation of Difficult-to-Process (chiefly chemical) Wastes" was discussed.

3.25 Provincial Council for Environmental Management in Utrecht

A steering group, created by the County Council (Gedeputeerde Staten) of the province of Utrecht, is formulating the duties of a future Council for Environmental Management in the province of Utrecht. The Provincial Council (Provinciale Staten) accepted the advice of the steering committee in its meeting of 16 May. A Council for Environmental Management was set up on 3 October. Ir. T. Teeuwen is an advisor.

3.26 Provincial Council for Environmental Care in Groningen

Ir. T. Teeuwen accepted an invitation to be an advisor.

3.27 Provincial Working Group for Chemical Wastes in Overijssel

Ir. T. Teeuwen is an advisor/observer in the working group for chemical wastes - a subgroup of the Provincial Council for Public Health.

4. Collection of data on waste materials; quantities and nature of waste materials

4.1 Waste Oil

The inventory of the kinds and amounts is nearly complete. The collected data was used in the drafting of the Chemical Wastes Act. In the last months of the year the problems with waste oil underwent some modifications because of the lower importation of crude oil. The effect of the increasing scarcity and the corresponding higher cost on the solution to the problem is being investigated. In association with the Ministry of Public Health and Environmental Hygiene, the SVA will make a recommendation to the minister in the course of 1974.

4.2 Urban Wastes, Normally-Processable Industrial Wastes and Similar Wastes

An investigation is ready to determine more precisely the amount of refuse that must be removed in each region. The problem associated with this determination lies in the fact that the various regions do not treat the categories in the same way. The investigation will attempt to bring more certainty into the problem and to determine the amount of household refuse, coarse refuse, refuse from small businesses, rubbish that is generated in the various regions. In advance, from the results of a questionnaire, one can see that the lack of data and the differing approach in the various regions will give an incorrect picture of the situation. Already a few visits have been made to the facilities where reasonably reliable data can be expected.

4.3 Automobile Tires

The problem of the removal of used automobile tires is urgent. A working group of KIVI has already given some attention to it, but it came to the conclusion that it is not possible to get an insight into the question of where the quantities of used tires are situated. Considering the views of a few firms which retread old tires, more and more uses of old tires are being slowly closed-off for their use. The SVA has started a new inventory and as well is collecting data on the various processing methods.

4.4 Chemical Wastes

4.4.1 Inventory of Chemical Wastes

An investigation into the industries in the Netherlands was looked at again by contacting again all plants which reported chemical wastes. A transcript of the results of the first phase of the investigation was given to these plants. In this re-contact, the processing method, recommended by the SVA for each chemical, was given. The plants were asked to report on the processors or transporters with which they already have contact and if possible the composition and amount of wastes per year, using the latest data available to the plant. A new processing method category list for the various chemical wastes was prepared for the processing of the data from the second questionnaire. In this, the wastes were clearly associated with their

processing method. The revised report was received from 75% of the registered plants. In order to assist in the completion of the questionnaires on the investigation of wastes which are difficult to process (mostly chemical wastes), several plants were visited.

4.4.2 Refuse in the Graphics Industry

Contact was made with four employer agencies, printers, bookbinders, offset and lithographers to obtain help from their members in the drafting of a meaningful questionnaire so that is would be possible to get an insight into the quality and quantity of chemical wastes released in the graphics industry.

4.4.3 Refuse in the Paint Industry

The VVVF sent a list through the Paint Institute (Verfinstituut) TNO to its members (about 100) with a set of questions on their usage of raw materials. With a few exceptions all lists have been received by the Paint Institute. The Paint Institute sent to the SVA data on the amounts of the various components in the paint refuse. The data will be processed further.

4.4.4 More intensive approaching of the plants in the region

As a result of the second questionnaire on the investigation of refuse which is difficult to process (mostly chemical wastes) the plants in a number of regions were contacted personally with the purpose of obtaining a more complete picture of the nature of the refuse and of the method of processing it in the plant.

4.4.5 Registry of Effluents CTI-TNO in Zuid-Limburg

The TNO-CTI was requested by the Ministry of Public Health and Environmental Hygiene to carry out an effluent registry of industrial pollution (air, water, soil) in Zuid-Limburg, for each plant site and for each plant activity. It was considered essential that the release of refuse at each site that was difficult to process be determined. This was to be used as a control and as a supplement to the previously collected data. The SVA assisted in setting up the registry for this; it included also the production process that led to the refuse produced.

4.4.6 Data Collection on the Pollution of the Soil by Mercury and Mercury Compounds

The question arose in the Contact Group for Pesticides on the degree to which mercury-containing residues result in an environmental problem. A literature search was carried out on the behaviour of mercury and mercury compounds.

4.4.7 Data on Heavy Metals

In order to increase the knowledge on the properties and behaviour of metals and their compounds in general and on the behaviour of metal hydroxides and oxides in the soil, several literature searches were carried out. Special attention was given to the solubility of heavy metals and their compounds in water with different pH's. In connection with possible sinter tests of metal hydroxides, remaining after ONO-

treatment, further studies were done on the volatility and on the melting points of various metals and their compounds.

5. Co-ordination of and Participation in Research Activities

5.1 Mobile Pulverizing Mills

For the research on urban refuse, on March 13 adoption tests were carried out on a test unit consisting of a pulverizing mill, driven by a gasoline motor, mounted on a trailer. The unit met completely the requisites of the SVA and was put to use for some period of time, for certification measurements, at the combustion facility in Alkmaar.

5.2 Investigation of the Sorting of Certain Components from Household Refuse

Introduction

The following components can possibly occur in the sorting of household refuse:

- paper and carton;
- tin cans (reclamation of tin);
- plastic;
- organic material (preparation of compost).

The plastic and organic material components are left out of consideration because of the large uncertainity associated with their sale. Nonetheless, a sorting facility, originally designed for the reclamation of paper and tin cans, can be modified, relatively easily, for the reclamation of organic material and plastic. The most interesting components - as far as reclamation is concerned - are undoubtedly paper and carton. Paper and carton comprise about 25% of the content of household refuse, and one can count on proceeds of between 60 and 80 guilders per long ton. For the time being, next to paper and carton, the reclamation of other materials has only a small effect on the profitability of a sorting facility. Any sorting facility must as far as possible be adapted to the quality and properties of the paper and carton. The production of paper and carton from home-grown woods will increase only slightly. The amount of wood produced is gradually increasing, but the quantities used for the paper and carton industry is still very small. Every year the importance of straw in the paper and carton industry decreases in importance. Probably within a few years straw will be almost completely replaced by old paper, so that the demand for old paper, if the import of foreign-grown wood remains constant, will increase from 600,000 long tons to 800,000 long tons. If a yield of 90% is attained, 900,000 long tons of old paper is necessary. Over the short term, important expansion of the Netherlands paper and carton industry can be expected, and as a result the demand for old paper (also considering that import remains constant) will rise even more to around 1,000,000 long tons around 1975.

With certainty one can say that old paper is almost the only home-grown raw material for the Netherlands paper and carton industry. From a preliminary investigation, it appears that paper and carton made from paper reclaimed from household refuse have the

same mechanical and physical properties as paper and carton manufactured from unsorted old paper in paper drives.

Sorting facilities for paper and carton

In principle one can differentiate between the installations which use the "wet" method and the installations which use the "dry" method. The SVA has already prepared a report on the wet method. The following observations can be made on this method in which household refuse is mixed with water (a mixture of 95% water and 5% dry matter):

- compared to the "dry" method, the "wet" method requires a relatively high investment;
- the energy consumption is high (about 100 kwh per long ton of processed refuse as opposed to 25 kwh per long ton for the "dry" method);

It must be kept in mind that the paper sorted in the "dry" method must later be pulped and purified in the cellulose or paper factory; an overall comparison on the energy consumption looks as follows:

- energy consumption for the "wet" method = 100 kwh/long ton
energy consumption for the "dry" method (after reclaiming half (12.5%) of the paper present in the household refuse (25%), 25 + 0.125 x 100 = 37.5 kwh/long ton.
Therefore in a first approximation it can be seen that the "dry" method uses about 60% less energy.
- the "wet" sorting process is relatively complicated, and results in higher costs as far as personnel, maintenance and plant safety are concerned;
- during the pulping of household refuse in water, organic material goes into solution; this means that water must be replaced in the system on a regular basis. This can lead to a waste water problem that can mean a significant cost factor;
- all this leads to the conclusion that the "wet" process from the standpoint of profitability , even for very large capacities (500,000 long tons of processed household waste and more), presents an unfavourable picture and that its application, for instance with other local processing methods, does not come into consideration.

Much research has been carried out and much experience has been obtained on the "dry" sorting of paper from household refuse. One can report on the research by the U. S. Bureau of Mines and the experience (over about ten years) with sorting facilities in Rome.

Investigation of a "dry" sorting method

An investigation is underway at the Central Technical Institute TNO on the sorting of paper and carton from household refuse. This investigation is supported by the SVA. The final evaluation will be done jointly by the TNO and the SVA. The investigation can be split into the following phases:

phase 1 - the testing of a sorting facility, set up on a laboratory scale, for paper using the windsifting method. This facility is already constructed and has a capacity of 1 long ton per hour.

phase 2 - the testing, under actual conditions, of a sorting facility with a capacity of 1 long ton per hour.

This facility will be built next to the waste grinding facility of the municipality of Haarlem, in such a way that it will operate under situations expected in practise. Moreover,one can investigate whether sifting is desirable or not and also what type of pulverizing facility can be applied to the site.

phase 3 - On the basis of the tests carried out in phase 1 and phase 2, a facility with a capacity of 10 long tons per hour can be developed.

Figure 1 shows a possible schematic for a sorting facility with a larger capacity, where one considers it in combination with a combustion facility. The tests, on a laboratory model, have shown that the syster involved is interesting enough to carry out tests on a larger model. A preliminary cost-profit analysis is acceptable: a sorting facility, using a dry method, can in certain cases be combined with other processing methods for wastes, such as controlled dumping or combustion.

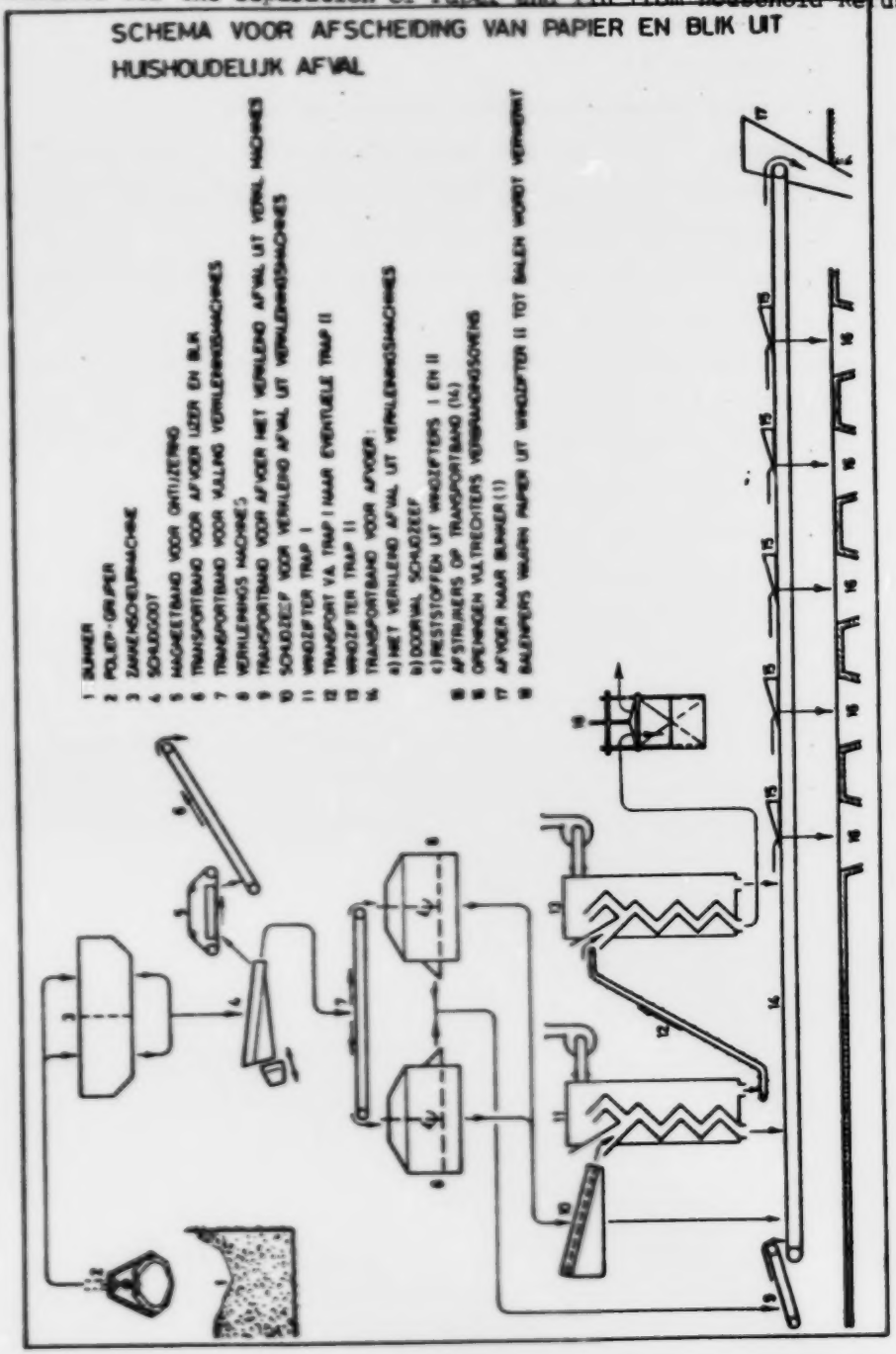
In summary the following can be concluded:

1. There will be an increasing need for old paper as a raw material for paper and carton manufacture.
2. On this basis one should be able to expect a reasonable return from the reclamation of paper from household refuse.
3. The tests and experience that has been obtained in the meantime, have shown that tests on a larger scale are justifiable when a "dry" sorting technique is used.

5.3 Processing Methods for Chemical Wastes

Contact has been made with a number of research institutes on the possibility of carrying out research on the appropriate processing methods. In the first instance, this investigation concerns the processing methods which can be applied on short notice, the action of metal concentrates and the treating of oil emulsions. In the second instance, research is being done on the reclamation of chemical wastes, as well as on the kinds of wastes released in small quantities and for which no processing method is available.

Schematic for the Separation of Paper and Tin from Household Refuse


SCHEMA VOOR AFSCHEIDING VAN PAPIER EN BLIK UIT HUISHOUDELIJK AFVAL
1 BUNKER
2 POLEP-GRIJPER
3 ZAAKENSCHEURMACHINE
4 SCHUDDOOT
5 MAGNEETBAND VOOR ONTIJZERING
6 TRANSPORTBAND VOOR AFVOER IJZER EN BLIK
7 TRANSPORTBAND VOOR VULLING VERKLEINERINGSMACHINES
8 VERKLEINERINGS MACHINES
9 TRANSPORTBAND VOOR AFVOER HET VERKLEIND AFVAL UIT VERKL. MACHINES
10 SCHUDZEEF VOOR VERKLEIND AFVAL UIT VERKLEINERINGSMACHINES
11 WINDZEFTER TRAP I
12 TRANSPORT V.D. TRAP I NAAR EVENTUELE TRAP II
13 WINDZEFTER TRAP II
14 TRANSPORTBAND VOOR AFVOER:
a) HET VERKLEIND AFVAL UIT VERKLEINERINGSMACHINES
b) DOORVAL SCHUDZEEF
c) RESTSTOFFEN UIT WINDZEFTERS I EN II
15 AFSTRIJKERS OP TRANSPORTBAND (14)
16 OPENINGEN VLATRECHTERS VERBRANDINGSOVENS
17 AFVOER NAAR BUNKER (1)
18 BALENPERS WAARIN PAPIER UIT WINDZEFTER II TOT BALEN WORDT VERWERKT

Figuur 1 Figure 1

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(FOR LABELS SEE OTHER SIDE)

1. Bunker
2. Scoop
3. Bag-opening machine
4. Vibrating bin
5. Magnet conveyer belt for removal of iron
6. Conveyer belt for the transporting away of iron and tin
7. Conveyer belt for the filling of the pulverizing machines
8. Pulverizing machines
9. Conveyer belt for the transporting away of unpulverized refuse from the pulverizing machines
10. Vibrating sieve for pulverized waste from the pulverizing machines
11. Windsifter stage I
12. Conveyer belt from stage I to a possible stage II
13. Windsifter stage II
14. Conveyer belt for the transporting away of:
    a) unpulverized refuse from the pulverizing machines
    b) material that passed through the vibrating sieve
    c) residue from the windsifter stages I and II
15. Strippers on conveyer belt (14)
16. Apertures for the funneling into the combustion ovens
17. Transport to bunker (1)
18. Baler where paper from windsifter II is processed

25<

The processing methods are:

a. combustion

b. removal of poisons, neutralization and de-watering (draining) - the ONO-method; and precipitation

c. treatment of oil emulsions

d. re-cycling and reclamation

e. containerization of hazardous chemical residues

f. controlled dumping of chemical residues

point a.

Combustion by itself is a familiar and much-used technique. The purification of hazardous gases by dry or wet gas cleansing is on the other hand less well-known. An inventory, now underway, on the possible techniques and research results will be continued.

point b.

The principle of an ONO-facility is well-known. Data on the quality of the water released as a function of the processing method applied is being collected.

point c.

Discussions are being held with concerns which market this type of facility. An evaluation of the existing techniques will be continued.

point d.

This deals with the regeneration of solvents, reclamation of heavy metals and hydrochloric acid from exhausted staining baths and the pyrolysis of combustible wastes. The regeneration of solvents by distillation is being done already in the Netherlands by a number of concerns. The reclamation of heavy metals is being done for precious metals such as silver (precious metal chemistry) and for Cu and Zn by the Duisburger Kupferhütte concern. The regeneration of the staining baths using the Sprühröst process is being studied. The evaluation, now underway, will be continued. Pyrolysis of combustible chemical wastes has not been studied up to the present time.

point e.

A study has been begun on the possibility of containerizing and then storing very hazardous wastes.

point f.

The problem concerning the controlled dumping of chemical wastes is being intensively studied. It appears that there are always residues for which the only way of disposing of them is to dump them on, or bury them in, the soil. The way in which this can be done in a responsible manner is being studied. The base has been laid for a study in which the problems associated with residues will be examined and in which a proposal can be made for carrying it out and for investigating it. The

treatment of chemical wastes is a key problem in the whole scheme of chemical waste disposal.

5.4 Test Dumping of Paint Wastes

Testing areas for paint wastes have been laid out on the dumping site of the municipality of Ambt-Delden, and the effect on the percolation water is being studied for the case of dumping paint wastes. A study is also being done on the processing of paint waste by combustion. This processing method can lead to environmental pollution such as air pollution for volatile metals; the slag containing possible poisonous metal compounds must also be dumped (ground water pollution).

An authorization, from the municipality of Ambt-Delden, under the Nuisance Act was obtained by the Public Body for Waste Removal in Twente (Openbaar Lichaam Vuilverwijdering Twente) (OLVT) before the start of the tests in Ambt-Delden. We are awaiting permission from the OLTV in Almelo. As far as the combustion test is concerned, contact has been rade with the Rijnmond Waste Processing, Inc. plant.

5.5 Test Dumping of Metal Hydroxide Muds

Metal hydroxide muds are released in metal surface-working industries, and in other industries as well. The plants use poison-removal, neutralization and draining facilities (ONO-facilities) in order to carry out the norms, prescribed by the water managers, which are to be followed for discharges of heavy metals into waste water. In effect, the problem of heavy metals is shifted from the water managers to the dumping site managers. For these kinds of compounds it is necessary to know the potential dangers that exist for soil and ground water and what requirements are necessary to avoid these dangers, in the cases where no other means of disposing the wastes are available than the dumping of them (in some fashion or other) onto or into the ground. A program of investigation is ready to obtain investigate this matter; among other things, attention will be given to percolation tests on the test areas for hydroxide muds, dumped separately or in combination with urban refuse.

5.6 Test Dumping of Chemical Residues

Regardless of the process or regeneration method applied to chemical wastes, one can assume that a certain amount of residue will remain, and that it must be dumped onto or into the ground. The question here is how this "dumping" should take place to prevent, in a maximum way as possible, any environment loading, and in the degree to which the dumping techniques, known for this waste, can be applied or in which direction they should be modified before application of the method. In the literature it is known that the joint dumping of chemical residues with urban refuse as a host offers some advantages in certain cases. Proposals are being developed to decide on the test dumping sites. At these sites the interaction between urban refuse

(largely organic matter) and chemical wastes (largely inorganic matter) will be looked into. At the same time one intends to look at how the occurrence of percolation water can be held back, to the largest degree possible.

5.7 Mud Processing in Westwoud

Mud processing tests have been carried out, in co-operation with STORA and the Noord-Holland Mud Commission, at the controlled dump in Westwoud. The first test used a conditioned mud with a dry matter content of about 15%; it was mixed with urban refuse in the ratio of 1:2. The second test was done with a non-conditioned mud that was dried, in a drying bed, to a dry matter content of about 22%; it was mixed with urban refuse as well in the ratio of 1:2. In both tests the results were not satisfactory: the terrain onto which this mud-urban refuse mixture was dumped was not only very wet for a period of several weeks, but it was also non-traversable for trucks. The tests will be continued using another processing technique.

5.8 Mud Processing in Beverwijk

The purpose of the investigation was to see the results of the dumping of sewage mud with a dry matter content of 5% onto a 5 m thick layer of urban refuse. Two test areas (I & II) were laid out at the Beverwijk dump in August. At the start of October the terrain around area I was filled and compacted. At the end of November a second layer was dumped; this was also put onto test area I. The location of the measuring pits gave great difficulty, since these were continually sinking or being pressed away by the adjacent truck traffic.

5.9 Sewage Mud as Fertilizer and/or Soil Enhancer

The Institute for Soil Fertility (Instituut voor Bodemvruchtbaarheid) in Haren carried out tests on investigating the degree to which muds could serve a useful purpose as a soil enhancer and/or fertilizer. The SVA prepared a transcript for this investigation, from the point of view of the possible availability of these wastes. In December Ir. S. de Haan from the IB gave a talk on this subject to a public staff meeting in Haren.

5.10 Investigation of Streaming Phenomena at Combustion Facilities for Wastes

At the begin of 1973 an investigation was begun, in co-operation with the Central Technical Institute TNO (Streaming Technique division), on streaming phenomena in combustion facilities for wastes. A number of problems which occur at existing facilities can be attributed, in principle, to mixing problems which can be studied, or even solved, using streaming techniques. The investigation concerned the following units of a combustion facility:

- the hearth;
- the cooling of the flue gas;
- the cleansing of the flue gas.

The hearth

This part of the investigation was to see under what conditions a complete combustion of the flue gas will be attained in the shortest possible distance above the combustion grate. For this one deals with specific mixing problems in which the shaping of the hearth and the dosing, using secondary air streams, play very important roles. A complete combustion of the flue gas in the shortest possible distance greatly influences the following aspects:

- the complete elimination of effluents of non-combusted flue gas;
- the decrease in the corrosion problem for facilities producing steam.

To study the streaming phenomena in question, measurements were carried out on a scale model. To supplement the investigation using the model, measurements were carried out, on an existing facility, on the distribution of temperature and gas concentrations.

The cooling of the flue gas

A few combustion facilities, yet to be constructed, will be equipped with cooling for the flue gas by using water injection. The investigation on a few important aspects of this method of flue gas cooling was split into a theoretical and an experimental part. The theoretical part will provide sufficient information on the laying-out of the experimental part. In the first instance, attention will be drawn to the following aspects:

- the determination of the boundaries at which one can go over from air cooling to air/water cooling and vica-versa. These situations occur when the operation of the oven is started or stopped;
- the maximum allowable droplet size for water injection;
- the optimal dispersal of the water in the flue gas stream to be cooled;
- the temperature distribution in the flue gas at various distances from the water injection point.

The measurements will be done in a column stoked with gas; the velocity of the flue gas and the flue gas temperature will be able to be adjusted independently and will be adjustable between limits which are experienced in actual practice.

The cleansing of the flue gas

In order for the electrofilter installation to have a good effect, it is very important that there be a uniform velocity and temperature profile at the entrance. The profiles mentioned are determined mostly by the flue-gas-conducting units between the point of flue gas cooling and flue gas cleansing. An investigation will be done on the conditions (channel cross-sectional areas, constrictions, bends and curves) which must be met in order to obtain a maximum streaming condition. Use will be made of models (streaming with air or water, on a scale of about 1:10) in which

the streaming can be made visible and be determined photographically.

5.11 Use of the Heat Produced in the Combustion of Refuse

Extensive calculations have been carried out for a number of projects on the use of the heat released in the combustion of refuse. In general, the following kinds of heat use will be considered:

1. generation of electricity
2. partial generation of electricity and heat delivery to an urban heating network
3. partial generation of electricity and heat delivery to a multi-step relaxation evaporator for water de-salination purposes.

In Chapter III, the problem associated with heat use is discussed.

5.12 Investigation of Effluents of Heavy Metals from Combustion Facilities for Wastes

This investigation in the first instance has a directed nature to it; the techniques for obtaining samples will be investigated. The experiment was carried out in co-operation with the Central Technical Institute TNO (Heat Technique Division). The measurements necessary were carried out at a medium-size facility. Four samples were collected and analyzed for the following:

a. the matter fractions
b. the condensed water
c. the matter collected in an activated charcoal filter and any precipitated gaseous matter
d. any mercury or other metal vapours collected in a gold tube.

Emission spectography, and perhaps in later phases, atomic adsorption methods will be used as analysis techniques. The results of this investigation may lead to a continuation of these effluent measurements.

5.13 Investigation of the Sorting of Certain Components in the Combustion Residues, coming from Combustion Facilities for Wastes

The composition of the combustion residues is as follows:

glass - about 30%
iron - about 20% (not including the pre-sorting of tin cans)
a few percent of non-ferro metals (aluminium, copper, zinc)
remainders (stones, earthenware, etc.) - about 48%

An extensive investigation was carried out in close co-operation with the Mining Division of the Delft Technical University with the view of obtaining results of the investigations carried out by foreign facilities on the reclamation of materials such as glass, iron and non-ferrometals. The following observations can be made on the approach of the investigation:

1. in the first instance, the Laboratory for Mineral Technology of the Mining Division of the Delft Technical University, under the direction of prof. dr. H. J. Roorda, has begun a basic analysis of the problem. Use was made of samples of combustion residues coming from various facilities in the Netherlands. In particular, the composition of the various grains was determined according to their specific density. An interim report has been prepared on the results of the investigation.
2. further determination on the value of hydro-metallurgical sorting will be made using the results of the first phase of the investigation.
3. should the results be of a positive nature, the proposal is to carry out extensive tests at a testing installation (and, as far as possible, under actual conditions).
4. in time, after further consultation, the establishment of a plant, preferably with 3 capacities, is contemplated, in connection with an extensive cost-profit analysis.

In 1974 another extensive report will be prepared. One should mention the research performed elsewhere: the activities of the U.S. Bureau of Mines and the French Bureau of Mines and Geological Research.

5.14 Investigation on Combustion Slag and Fly Ash

Four test areas (each of 100 m^2) were filled, at the end of August, in the "Hoge Bergse Bos" near Rotterdam, as follows:

Test area I with fly ash, from Rotterdam,

Test area II with slag from which iron has been removed, from Rotterdam,

Test area III with "dirty slag", from the Hague,

Test area IV with "dirty slag" from Alkmaar.

The delivery of the slag from Alkmaar occurred with considerable difficulty because of the poor terrain conditions and of the problems of trucks sinking and tipping.

In December the percolation water from each of the areas was sampled and analyzed by the RIV.

5.15 Percolation Water Investigation in Tilburg

The investigation of the quantity and quality of the percolation water from this highly compacted dump is continuing. Gas formation under the measuring pit continues to cause difficulties as far as corrosion of the apparatus and of the batteries is concerned. After a special coating was applied to the volume meter and after placing the battery in a separate pit above ground, the problems were overcome. Only test area II had any percolation water. The drains for test area I were kept clean with a special apparatus. A continuous formation of gas in the measuring pit was confirmed. In September and December a sample of percolation water was analyzed by the RIV.

5.16 Dumping Site at Ambt-Delden

The quantity and quality of the percolation water, the ground water and the surface water were investigated further. This investigation took place after a request from the Inspector of Public Health, charged with maintaining a control on the environmental hygiene in Overijssel.

5.17 Dumping Site in Ambt-Delden (test areas)

In early March a layer was dumped on the SVA test areas (III & IV). Temperature sensors were placed in it at depths of 1.25, 1.50 and 1.75 m. The quantity and quality of the drainage water was investigated here also. In February percolation water and ground water were investigated for heavy metal content. In June the investigation was repeated. A planned investigation of the soil directly under the dump, by the Institute for the Application of Atomic Energy to Agriculture,was not able to take place this year.

5.18 Dumping Site in Westwoud

The ground and surface water at this dumping site will be sampled and analyzed, in co-operation with the various institutes. An expanded research plan has been prepared for this purpose; it will be started in 1974. The SVA will do the calculations and write the report.

5.19 Dumping Site in Rijssen-Markelo

Because a portion of the dumping site had to be shifted because of the construction of the E8 highway, it was possible to investigate the soil directly under the dump site. A number of soil samples were taken with the co-operation of the Institute of Culture Techniques and Water Housekeeping (Instituut voor Cultuurtechniek en Waterhuishouding) and of the Institute for Soil Mapping (Stichting Bodemkartering). The data collected will be worked into a scientific publication to be prepared by the SVA and Stiboka.

5.20 Plantations Tests on Dumping Sites

An investigation of the rooting of the plantation at the dumping site in Tilburg has continued in co-operation with the Bosbouw Testing Station.

5.21 The physical, chemical and microbal processes in and under a dumping site

The processes going on under a dumping site are only scarcely known. Since pollution of the ground water almost never occurs in practice as a result of the percolation water escaping from a dumping site, indications are that chemical, physical and microbe processes cause changes in the soil layer between the dumping site and the ground water. These changes result in a modification of the dissolved compounds so that they are trapped in the soil layer. Many contacts have been made with experts in similar institutes on the problems in this research field. In order to be able to study these processes further, a test was set up in which various soil types have been mixed by shaking them with water from the Delden dump.

The column test presently underway is a further extension of this. An opportunity to obtain information on this, in practice, occured in Markelo, where a highway was run through a dumping site in such a way that a portion of the site had to be removed. Soil water samples and gas analyses were also carried out here. The analyses were done as follows: the soil analysis in co-operation with Stiboka, the water analysis by the RIV, and the composition of the gas sample by the gas chromatograph of the division of Organic Chemistry of the Agricultural College. The result is that there is a more fundamental insight into the processes which occur under a dumping site. It appears, from the investigations in practice (CO_2-content and redox potentials) and from a literature search, that there is a reduction zone directly under the dump, then a transition zone, followed by an oxidation zone. In the reduction zone microbe transformations are taking place by anaerobic and/or facultative-aerobic microorganisms. The components produced form new chemical compounds with the cations in the percolation water; these chemical compounds appear to be, in part, nonsoluble. At the same time cations can be adsorbed onto the continually regenerating slime. Microbiological investigations are planned. Column tests, in which columns are filled with various types of soil, will give a picture of the part that adsorption and precipitation play in the cleansing action of the soil. The aerobic breakdown of the percolation water with the help of activated mud was tested in a discontinuous laboratory set-up. A test using continuous culture is in preparation. The fraction of household refuse that can be leached was determined in the lab by shaking household refuse in buffer solutions of various pH's. That gases are formed in anaerobic transformations is known. Much research must still be done on the quantity produced and on the composition of the gas. This investigation has barely begun although some discussions have been held with the Institute of Culture Technique and Water Maintenance (Institude voor Cultuurtechniek en Waterhuishouding). It is hoped that the research can be expanded in 1974. Regular contacts are maintained on this problem with the division of Agricultural Chemistry and Microbiology of the Agricultural College, with Stiboka, ICW and ITAL.

5.22 Dumping Site in Maarsbergen

Five testing areas (each of 100 m^2) have been laid out in the dumping site in Maarsbergen. The reason for this is to see if any percolation water results when urban refuse, highly compacted in a short period of time, is dumped in a layer of about 8 m thickness. Since the testing areas border on one another, an investigation will be made of whether the same channels are used by the percolation water, should any be released. In this way one should obtain a definitive answer to the question of whether certain testing areas, never or only rarely, produce percolation water while others regularly produce more percolation water. One probably shall have to

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wait a sufficiently long period of time (more than a year) before one can with certainty give an answer to this question.

5.23Supervision of the Investigation of Chromium Oxidation, carried out at the Inorganic Laboratory of the State University in Leiden

A study is being made of the oxidation in air, at various temperatures, of tri-valent chromium present in chromium hydroxide into hexa-valent chromium.

5.24 Literature search on the behaviour of metallic hydroxides

A literature search was carried out on the behaviour of metallic hydroxides. Colloidal phenomena, solubility and draining behaviour were studied.

5.25 Research in the Laboratory

The following investigations and measurements, among others, have been carried out in the laboratory:

- investigation into combustion residues: determinations were made on the percentage of free humidity, decomposability and combustibility; the ash melting point was determined.
- automobile tires: from the tread and sidewalls of a small automobile tire, a regular-size automobile tire and a tractor tire, determinations were made of: %volatility, ash, combustibility, C-fix, and fueling value.
- Grinding tests with the Hazemag Grinder. The loss in humidity when household refuse was ground in the Hazemag Grinder was measured.
- comparison of the various determinations of decomposibility of a random and of a known sample of slag by: EMPA, EAWAG, and TüV (Düsseldorf)
- Leaching tests on household refuse that has been ground up. After shaking household refuse with a buffered solution, pH, conductivity, and zinc and calcium content were determined.
- determination of the humidity level of a few chemical residue samples from the facilities for removing poisons in Iserlohn and Schwabach.
- percolation tests with hydroxide muds. From the percolation tests with iron and zinc hydroxides, the values were determined for: pH, conductivity, iron and zinc content.
- from a few samples of chemical waste obtained from a certain industry, determinations were made of: pH, calcium, chromium (trivalent and hexavalent); sulphate and COD.
- set-up of six soil columns. The values were determined of: pH, conductivity, COD, Kjeldahl-nitrogen, iron and chloride.
- aerating of percolation water with active mud. Values were determined for: pH, conductivity, COD, Kjeldahl-nitrogen, iron, mud-index, and dry matter content.
- shaking tests of percolation water with quartz covering sand, with iron-containing covering sand, sea clay, clay both with and without lime content.

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The following were determined: pH, conductivity, zinc, Kjeldahl-nitrogen, and sulphate.

- a number of parameters (household refuse, slag, fly ash) were determined as part of the guarantee check on the combustion facility in Alkmaar.
- mud from the dump in Westwoud. The percent humidity was determined.
- the determination, from a number of percolation samples, from the dumps in Ambt-Delden, Tilburg, Westwoud, Beverwijk and Rotterdam, among other things, of: pH, conductivity and iron.
- percentage of volatiles in household refuse. The influence of the factors of: time, oven volume and the reducing environment on the determination of the volatile parts of household refuse were studied.
- in order to carry out colorimetric and photospectrometric analyses, the merits of the Hach-Colorimeter and the Bausch-Lomb Spectronic 88 were evaluated.
- column tests. Percolation tests were carried out on iron, nickel, chromium, zinc and copper hydroxides.
- removal of poisons from wastes, chromate and chromic acid baths, originating in the metal surface-working industries. The investigation was directed to the merits of the various methods which exist for the reduction of hexavalent chromium in chromic acid baths to trivalent chromium. One succeeded in this experiment in achieving a new method of poison removal.

6. Visits to Plants and Concerns

6.1

In connection with the evaluation of tenders for processing facilities for urban refuse, it was necessary to make visits to similar facilities in Belgium, Switzerland and Germany.

6.2

In order to provide assistance in the completion of the questionnaire on the chemical waste investigation and to observe the handling of chemical wastes in situ, it was necessary to visit a number of plants and concerns.

6.3 In order to study the processing methods for chemical wastes, discussions were held with and visits were made to (potential) processors and processing facilities in and outside the Netherlands:

Cindu te Uithoorn;
Bredero-Purle te Utrecht;
Duisburger Kupferhütte te Duisburg BRD;
Grondmet te Rotterdam;
Bos en Kalis te Papendrecht;
Cadix te Rotterdam;
Edelchemie te Panheel;
Zentrale Entgiftigungsanlage te Iserlohn BRD; - central poison removal facility
Wimborne - C.P.R. te Bergen op Zoom;
BASF te Ludwigshafen BRD;
Südhessische Verbrennungsgesellschaft m.b.H. te Biebisheim BRD; - south Hessian combustion facility
Kali und Salz AG te Kassel BRD;
Stellinger Moor te Hamburg BRD;

Gesellschaft zur Beseitigung von Sondermüll in Bayern m.b.H. te München BRD; - facility for the removal of special kinds of refuse
Zweckverband Mittelfranken te Schwabach BRD;
Glasurit Werke te Hiltrup/Westfalen BRD;
Redland-Purle te Londen GB;
Kommunekemie te Nyborg Denemarken;
Pollution Control Ltd. te Kalundborg Denemarken;
AB Industridestillation te Stockholm/Zweden;
Daester-Fairtec AG te Basel Zwitserland;
Publieke Werken te Roosendaal; - public works division
Publieke Werken te Eindhoven;
Reinigingsdienst van Amsterdam, Afd. Bedrijfsafvalwater; - cleansing service - industrial waste water division
Afvalverwerking Rijnmond te Rotterdam;
Vitrite te Middelburg.

te = in

BRD = Federal Republic of Germany

As well discussions were held with engineering bureaus, suppliers and builders of facilities.

6.4

Visits were made to the Drscherbruch Central Deponie, the Technical University in Braunschweig and to the dumping site in Wiesbaden. The purpose of these visits dealt with:

1. the consequences of dumping chemical wastes, in combination with urban refuse.
2. the biological decomposition of percolation water.
3. controlled dumping - the German experience.

7. Conferences and Symposia

7.1

A "One-day Symposium on the collection and disposal of hazardous wastes", organized by the Institute of Public Cleansing, held on 12 January in Manchester (England) was attended.

7.2 The Megista conference, in February in Wageningen was attended. Almost all facets of interest to the fertilizer, liquid manure and odour problem, originating primarily in the bio-industry, were discussed.

7.3

A lecture, titled "Environmental Management in Belgium", held at the Free University in Brussels on 16 March, was attended.

7.4

The VBG conference "Refuse Combustion", held in Essen on 3-4 April, was attended; the following topics were treated:

- federal refuse reroval legislation and refuse combustion.
- on oven works and refuse combustion facilities - layout, construction and initial experience at the site.
- the second generation of modern refuse combustion facilities - Kessel facility - construction details and experience at the site.
- the refuse combustion facility "Botlek" in the industrial zone of the city of Rotterdam.
- ash reroval at refuse combustion facilities.
- flue gas cleansing at refuse combustion facilities.
- experience with flue gas cleansing at combustion facilities.
- operating experience at combustion facilities in Chicago and Harrisburg (USA).

7.5

The exhibition "Environment 1973", held in Utrecht on 13 April, was attended.

7.6

The exhibition Interclean, held in Amsterdam on 2 May, was attended.

7.7

A syrposium, held by the division of Agriculture Chemistry of the Agricultural College (LH) in Wageningen on 25-26 July, was attended; Prof. Raats (Wisconsin) presented lectures on: "Convection and Dispersal of Gases and Dissolved Matter in Soils" and on "Multi-dimensional stationary flow and unstable flows in non-saturated soils.

7.8

Achema, in Frankfurt am Main, was visited in July.

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7.9

"Instrument", held in Amsterdam in August, was visited.

7.10

A few colleagues attended the KNCV conference "Photography and the Environment", on 31 August.

7.11

A one-day conference. Held in Essen on 26 September, on the topic of "Waste Industry" in Nord Rhein (North Rhine)-Westfalen (Westphalia), was attended. Reports were given on the prognosis and optimization of waste removal methods.

7.12

Participation was made in an excursion of the Netherlands Union for Waste Water Purification (Nederlandse Vereniging van Afvalwaterzuivering), on 4 October. Sewage water purification installations and mud combustion facilities in Dordrecht were visited.

7.13

Envitec, in Dusseldorf, was visited on 7 October.

7.14

A lecture by the European Common Market (EG) Commission of Environmental Affairs, held in Amsterdam on 23 October, was attended.

7.15

The symposium "Geochemistry and the Environment",held in Utrecht on 23 November, was attended. The lectures dealt with the natural mobility of a few "sinister" elements and the increase in their mobility because of human intervention.

7.16

"Re-cycling", held in Zurich from 28-30 November, was attended. This conference was organized by the Gottlieb Düttweiler Institute.

7.17

The symposium "Transport Phenomena in Ground Water of Pollutants", held in Utrecht on 30 November, was attended. The symposium was organized by the Hydrological Council (Hydrologische Kring).

7.18

The public staff meeting of the IB, held in Haren (Groningen) on 20 December, was attended. Ir. S. de Haan and Dr. W. van Driel gave lectures on heavy metals in purification muds, their effect on soil and vegetation, and as well the possibility of using this mud in agriculture.

8. Lectures Given

8.1

Ir. J. A. van der Kuil gave an introductory lecture on the "Re-cycling of Wastes" on 23 January to the Zeist Environmental Care Centre in Eerbeek, on the occasion of an excursion to the paper factory "De Hoop".

8.2

Ir. T. Teeuwen gave a lecture on 5 February on waste removal as part of the Second Seminar on Environmental Science, organized by the Netherlands Institute of Preventative Medicine TNO.

8.3

Ir. J. A. van der Kuil, together with Ir. W. P. Fornerod of the Container Institute (Instituut voor Verpakking) TNO and W. G. Boessinch of the Union of Glass Concerns (Verenigde Glasfabrieken) for the Commission of Recycled Packaging and the Environment (Kommissie Retourverpakking en Milieu) in which the Institute of Labelled Goods (Stichting Het Merkartikel) and the Institute of Packaging and the Environment (Stichting Verpakking en Milieu) co-operate, gave a lecture on Recycled Packaging and Waste Removal".

8.4

Ir. E. J. Mesu gave an introduction to "Wet Processing of Liquid Fertilizers, in combination with Urban Refuse", on 28 February at the Mecista conference held in Wageningen.

8.5

As part of the environmental course at the Christian Intermediate Agricultural School (Chr. Middelbare Landbouwschool) at Putten, Ir. E. J. Mesu and Ir. J. A. van der Kuil gave three lectures on wastes and waste removal. Ir. E. J. Mesu, as part of the same course, organized and accompanied, on 16 March, an excursion to a few waste processing sites.

8.6

The SVA participated intensively in the course "Solid Wastes and Public Cleansing", organized by the Institute of Post-Academic Education in Health Techniques (Stichting Postakademiale Vorming Gezondheidstechniek). Because of the great interest a repeat of this course appears to be necessary. The first course took place from 28-30 March; the repeat course, from 9-13 April. Colleagues of the SVA gave the following lectures:

Ir. T. Teeuwen	Historical Development
Ir. T. Teeuwen	Nature and Arounts of Wastes: Processing Methods
Dr. I. H. Anthonissen	Chemical Wastes which are difficult to process, inventory of them and problems involved with ther

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Ir. B. G. Kreiter	Combustion as a Processing Method for Chemical Wastes
Ir. E. J. Mesu	Controlled Dumping
Ir. E. J. Mesu	An investigation into the environmental hygienic aspects of dumping
Ir. T. Teeuwen	Organization and economic aspects; regional and national approaches to the problem
Ir. J. A. van der Kuil	Recirculation and re-cycling of wastes

8.7

During a press conference of the Union of Paper and Carton Producing and Processing Industries, held in the Congress Hall in Delft on 27 March, Ir. J. A. van der Kuil gave a lecture titled, "The increasing flow of wastes and the re-cycling of old paper and cartons".

8.8

Dr. I. H. Anthonissen gave a lecture, titled "The Processing of Chemical Wastes", to the Groningen departmental meeting, held in Wijster on 10 April.

8.9

Ir. E. J. Mesu gave a lecture on "Waste Removal" to the Commission on Soil and Environmental Hygiene" of the Institute of Experimental Farms in the IJsselmeer Polder (Stichting Proefboerderijen IJsselmeerpolders) on 13 April.

8.10

During the spring conference of the Netherlands Union of Cleansing Directors (Nederlandse Vereniging van Reinigingsdirekteuren), held in Amsterdam, Ir. E. J. Mesu gave a lecture, on 3 May, titled "Are there any concerns anyway about the controlled dumping of wastes?".

8.11

Ir. J. A. van der Kuil participated in a symposium of the study group "REK" of the St. Vigilius Institute of Technology (Hogere Technische School St. Vigilius) on 21 June in Breda; the symposium discussed the topic "Removal and Re-cycling of Wastes in Noord-Brabant.

8.12

Ir. J. A. van der Kuil prepared a lecture, held on 3 September, for undergraduates in the N4 programme of the Agricultural College in Wageningen; it was titled "Packing Wastes in Waste Removal Problems".

8.13

Ir. T. Teeuwen, as part of the course on Stock Raising and the Environment, given at the LH in Wageningen, gave a lecture, on 13 September, on the removal and re-cycling of wastes in which special attention was given to wastes originating in agrarian and agricultural processing plants.

8.14

Ir. E. J. Mesu gave an introduction on the requirements that controlled dumping must meet, from environmental hygienic and esthetic considerations, during a public meeting for the city of Assendelft.

8.15

Mr. P. Schreuder gave a lecture, titled "Why is waste legislation necessary anyway?" at a meeting on 2 October of the Tribologic Council (Kring Tribologie) of the Union on the Knowledge of Matter (Bond voor Materialenkennis); the theme of the meeting was the "Consequences of Environmental Legislation on the Metal-Processing Industry".

8.16

Ir. T. Teeuwen gave a lecture on the sugject: removal and re-cycling of wastes - the environmental hygienic, planological, economic and organizational aspects. It was given as part of the course "Environmental Hygiene and Environmental Management", organized by the Royal PBNA, on 19 October.

8.17

Ir. J. A. van der Kuil gave a lecture on "Packaging and the Environment", at the symposium of "Packaging and Foodstuffs", organized by the Netherlands Union of Nutrition and Foodstuffs Technology (Nederlandse Vereniging voor Voedingsleer en Levensmiddelentechnologie).

8.18

Ir. E. J. Mesu gave a lecture titled "Measurements of Trace Elements in the Ground Water under various dumping sites", at the symposium of the Hydrological Council (Hydrologische Kring), held in Utrecht on 30 November.

9. Recommendations and Advice

9.1

Information was given to a number of Provincial Inspectors of Public Health, including Gelderland, Brabant and Zeeland, on the problem of chemical residues. During the discussion, emphasis was placed on the disposal of metal hydroxide muds.

9.2

Information was given to the Provincial Environmental Service in Utrecht on the situation now existing and the possibilities of dealing with the problem of junked cars.

9.3

The SVA participated in a discussion on the regeneration of re-cycled oil in the province of Noord-Holland, held in the provincial house in Haarlem on 16 April 1973.

9.4

An explanation was given on the possibility of re-cycling tin, paper, glass and plastic at the subcommission on soil and ground water pollution of the Environmental (Noord-Holland) Hygiene Commission, on 7 May.

9.5

Information was given on the investigation of chemical wastes, at the provincial house in Haarlem on 18 June.

9.6

Information was given on hospital wastes to a meeting of the Subcommission of the Noord-Holland Environmental Hygiene Commission on soil and ground water pollution and wastes.

9.7

Information was given to a meeting of administrators of cleansing services on the problems associated with the introduction of plastic bags; special attention was given to the imposition of a cleansing tax.

9.8

Since various countries have introduced measures dealing with waste oil, the EG (European Common Market) Commission requested some consultation. A point of view on this was developed and it was discussed by the delegations from the ECM member states. On request from the Ministry of Public Health and Environmental Hygiene, the SVA attended 3 2-day sittings of the ECM-commission.

9.9

SVA gave some oral advice on the regulation of industrial and chemical waste, after a request from the County Council (Gedeputeerde Staten) of Zuid-Holland.

9.10

Much oral and written information was provided on the problems associated with wastes; The topic, "Re-cycling of Refuse", is becoming an increasingly important one. In this matter much information was given to municipalities, environmental groups, students, etc.

10. Representations and Attendance

10.1

On 7 May the SVA attended the driving of the first pile of the waste combustion facility in Duiven.

10.2

Ir. T. Teeuwen and Ir. J. A. van der Kuil were appointed by the Ministry of Public Health and Environmental Hygiene to be examiners for the OPOR examination. The examination was held on 9 May in the Pavilion of the Berghotel in Amersfoort.

10.3

Ir. T. Teeuwen attended the inauguration of the combustion facility of the GEVUDO in Dordrecht on 7 June.

10.4

Ir. B. G. Kreiter attended the retirement ceremony of Mr. F. J. Besier, advisor to the Ministry of Public Health and environmental Hygiene and member of the board of the SVA.

10.5

On 26 June, Ir. T. Teeuwen attended the retirement ceremony of Drs. H. F. Louwe Kooijmans, Inspector of Public Health, who had been in charge of environmental hygiene control in Gelderland.

10.6

On 2 November, Ir. T. Teeuwen attended the retirement ceremony of Ir. E. Otten as director of City Cleansing (Stadsreiniging) in Amsterdam.

10.7

Ir. T. Teeuwen attended the retirement ceremony of Ir. P. Vrijburg of RIZA on 19 December.

11. Ancilliary Organizations

11.1 Netherlands Union of Cleansing Directors (Nederlands Vereniging van Reinigings direkteuren)

Attendance was made at the spring and fall conferences of this union, held in Amsterdam on 2-3 May and in Rotterdam on 20-21 September. Ir. T. Teeuwen presented a lecture at the fall conference on the topic "Wastes which are difficult to process (chiefly chemical wastes)".

11.2 Contacts with TNO Industrial Organizations

The existing contact with the TNO Industrial Organizations was intensified, so that as much possible use could be made of each other's special knowledge in the study and of the problems associated with waste processing and the associated known environmental aspects. The visit made by the TNO Industrial Organization to SVA on 20 December 1972 was returned on 4 April. In the morning a working discussion was held in Delft on the activities of the various TNO Industrial Institutes and the activities in the fields above were explained. In the afternoon visits were made to a few laboratoria.

11.3 ISWA

Ir. T. Teeuwen participated in the deliberations of the Scientific Council of ISWA (Wissenschaftliche Beirat), held in Zurich on 23 March and on 22-23 November.

The following were discussed:

- the ISWA participation in a conference to be held in Montreal in the fall of 1974 where topics such as "Resource Recovery from Solid Wastes" and Management of Hazardous Wastes" are on the program.
- the program and the organization of the ISWA conference 1976 to be held in Padua.
- topics for the ISWA publication bulletin.

12. Publications in Journals

12.1

The lectures,given by Ir. T. Teeuwen, Ir. J. A. van der Kuil and Ir. E. J. Mesu at the conference of the Netherlands Union of Landscapers (Ned. Ver. van Tuinarchitekten) in November 1972, were published in the February issue of the monthly "Plan".

12.2

An article by Ir. E. J. Mesu, titled "The Covering Soils at Controlled Dumping Sites", was published in the May issue of the Technical Monthly of Municipal Cleansing.

12.3

The lecture by Ir. E. J. Mesu, "Are there any concerns about controlled dumping anyway?", given at the spring conference of the NVRD, was published in the June issue of the Technical Monthly.

12.4

Ing. J. J. Vos published in one of the March issues of the PT/Aktueel a comment on the article "Refuse Combustion is a Waste of Energy", which had appeared in the 10 January issue of the same journal.

12.5

In the 4 April issue of PT/Aktueel an article, written by Ir. J. A. van der Kuil for "Milieu'73", titled "Re-cycling of Wastes", was published. The same article was also published in the Haverloods and in the NVRD Technical Monthly for Municipal Cleansing.

12.6

In the November 1973 issue of the Technical Monthly for Municipal Cleansing was published a lecture, titled "Wastes which are difficult to process", given by Ir. T. Teeuwen to the fall 1973 conference.

12.7

The lecture by Mr. P. Schreuder, titled "Why is legislation on wastes necessary anyway?", was published in the 15 November issue of the trade magazine Metaalbewerking (Metal Processing).

12.8

An article, titled "Disposal and Utilization of solid wastes in the Netherlands and the role of the Institute for Waste Disposal in this country", by T. Teeuwen was published in the December issue of the ISWA Information Bulletin.

CHAPTER III

Energy from Wastes?

- a lecture given by Ir. B. G. Kreiter.

I. Introduction

There are a few ways one can think of processing refuse and obtaining energy either directly or indirectly from the refuse. This can be done indirectly in the following ways:

- pyrolysis (liquid and gas products by heating in an oxygen-free atmosphere)
- fermentation (Production of methane).

One should mention that both methods, as far as the treatment of solid waste is concerned, are still in the development stage and consequently are not being used on a large scale. The direct method of energy generation, by combustion, in specially developed facilities, has been used since the beginning of this century, originally in the large cities of West Europe and later in Japan, Canada and the United States as well. In the following, the direct energy generation from wastes will be discussed. By waste we mean: solid urban refuse. In the consideration of the possibility of using the heat generated in the combustion of wastes, the following aspects are of importance:

- the amount of refuse which is being burned at the present time, and the amount which will be burned in the near future.
- the method of using the combustion heat.
- the extra costs or extra benefits, if any, accompanying the use of this heat.
- the savings of primary energy as well as the percent contribution of the national energy need.

II. The present-day methods for processing wastes

In the Netherlands about 3,500,000 long tons of urban refuse are produced each year. This amounts to about 280 kg per person per year. Urban refuse consists of:

- household refuse (about 60%)
- coarse refuse
- industrial refuse
- market and street refuse.

At the present time urban refuse is processed in the ways shown below:

- combustion	about 28%
- VAM transport, fermentation in the open air, partial composting and the dumping of non-composted wastes (van Maanen system)	about 15%
- uncontrolled dumping	about 52%
- controlled dumping	about 5%

It should be mentioned that the amount of refuse which at the present time is being burned (1,000,000 long tons) comes mainly from the large metropolitan areas in the country (Amsterdam, Rotterdam and the Hague and their environs). These cities have combustion facilities which, during the time of combustion, use the heat for the generation of electrical energy. In the near future 1,500,000 long tons of urban refuse will be burned; the present treatment of the use of the heat generated must be related to the difference in the quantities mentioned (by 500,000 long tons).

III. Possibilities of using the heat produced in the combustion of refuse

The following types of heat use can be imagined:

- delivery of heat
- delivery of electricity
- delivery of heat and electricity (the so-called heat-power combination).

The delivery of heat alone will not be considered because with relatively little extra costs electricity, expecially for use within the plant, can be generated.

In V, two examples will be calculated:

- the generation of electricity for delivery to the public electricity network and to the factory itself
- the delivery of heat to an adjacent plant for the production of distilled water together with the generation of electricity for use in each of the plants.

IV. Cost Aspects

IV-1. Cost factors

The following factors play an important role in the cost aspects for all types of heat use:

- the extra investment (steam kettles, turbine generators, buildings)
- the greater number of personnel
- the extra operating costs
- the possible energy production
- the proceeds from the energy delivered
- the savings in energy
- the relation of the proceeds and the extra costs as a function of wages, material and fuel costs as a function of time.

One can make a comparison between installations with and without the use of heat using the following factors:

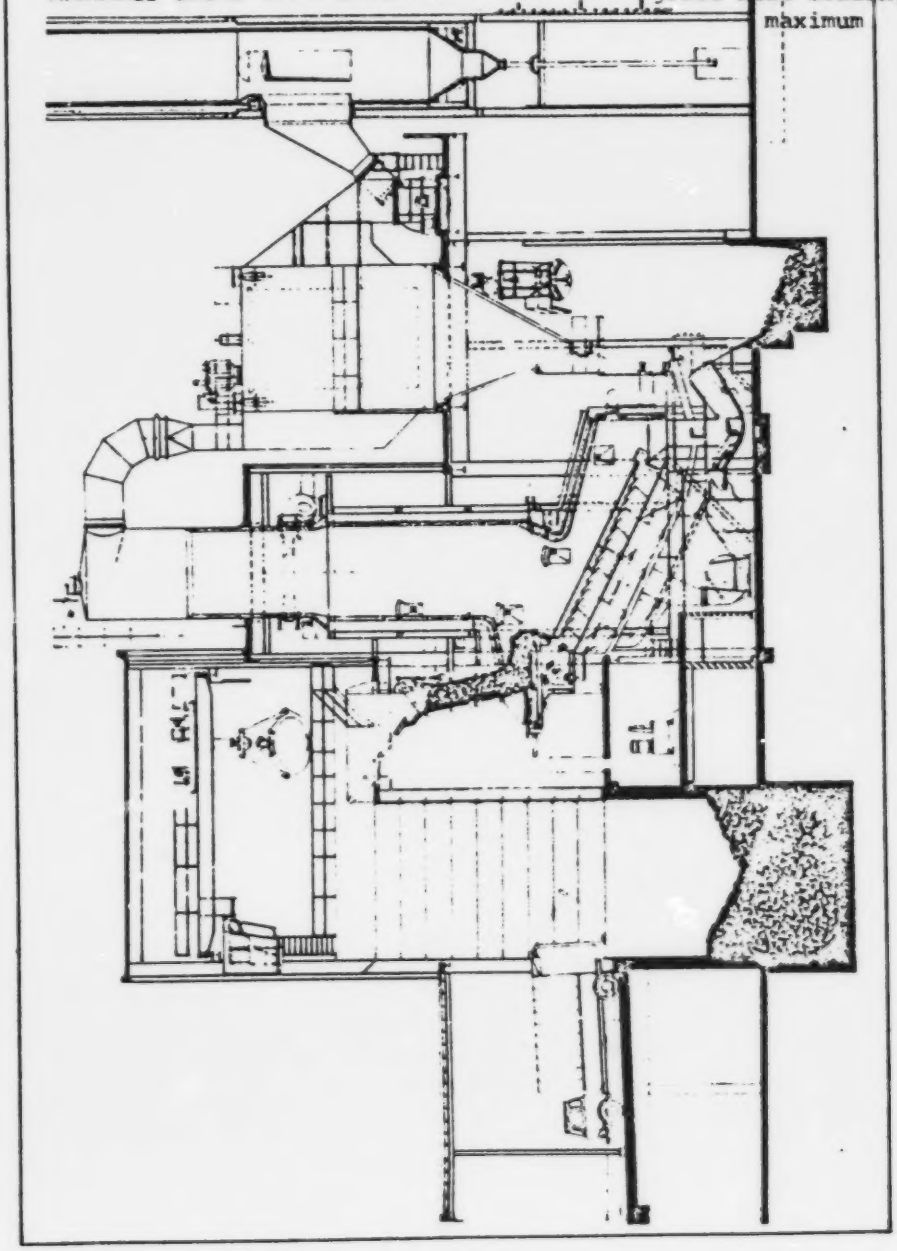
- the extra yearly fixed costs, consisting of capital, personnel and maintenance costs
- the net extra running costs as a difference from the extra fixed costs, taking into account the savings and proceeds of energy not used and of the energy delivered, respectively.

Combustion Installation without making use of the heat produced

VERBRANDINGSINSTALLATIE ZONDER WARMTEBENUTTING

KAPACITEIT 6 t/h, MAXIMALE STOOKWAARDE 2000 kcal/kg — capacity 6 long ton/h - fuel value maximum

MAXIMALE BRUTO-WARMTEBELASTING 12.10^6 kcal/h, gross heat loading maximum



Figuur 2 Figure 2

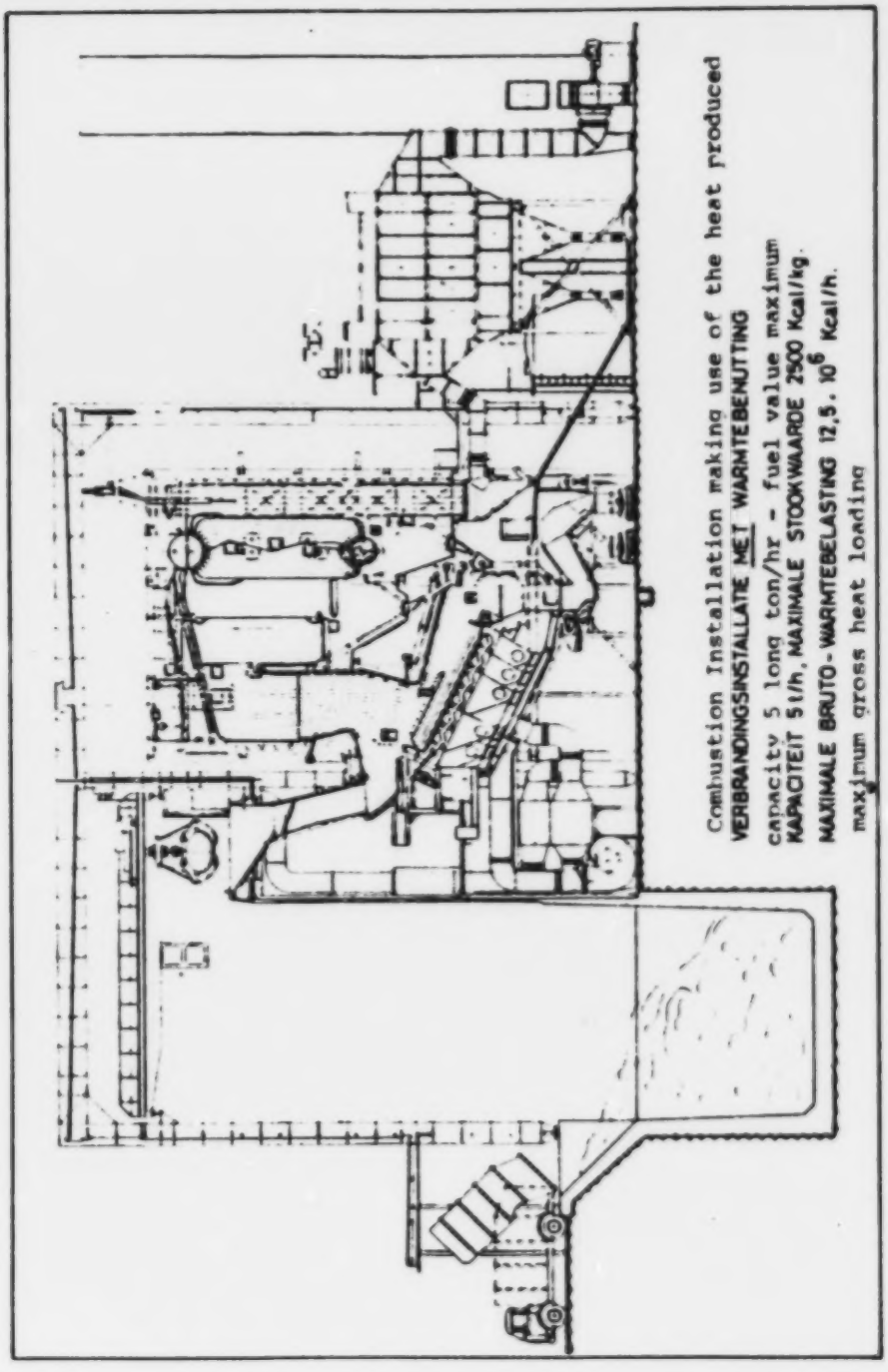

Combustion installation making use of the heat produced
VERBRANDINGSINSTALLATIE MET WARMTEBENUTTING
capacity 5 long ton/hr - fuel value maximum
KAPACITEIT 5 t/h, MAXIMALE STOOKWAARDE 2900 Kcal/kg.
MAXIMALE BRUTO-WARMTEBELASTING 12,5. 10^6 Kcal/h.
maximum gross heat loading

Figure 3 Figuur 3

In order to make possible a far-reaching cleansing in the electrostatic filters, it is necessary to have the flue gas in a combustion facility cooled to 250-300° C. This cooling of the flue gas in installations, making use of the heat produced, is done by water injection. This method has been used in practice for the last few years. The difference in the operation of each type of facility is made clear in figures 2 and 3. The facilities shown have almost the same heat loading and are only one example of the combustion facilities that can be supplied by specialized firms.

IV-2. Derivation of a few formulae

The net extra operating costs

In comparison to the case where no heat is made use of, the extra operating costs can be calculated as follows:

ΔE = extra fixed costs minus the savings from energy non-purchased and the proceeds from the sale of energy, expressed in guilders/year.

The formula is given below:

$$\Delta E = (\Delta V - G(PK1 + O)) \quad (1)$$

where

ΔV = the extra fixed costs (consisting of capital, personnel and maintenance costs) in guilders/year

G = the amount of refuse burned in long tons/year

P = the steam consumption in the combustion facility itself in kwh/long ton of refuse

K1 = the cost of electrical energy for large consumers, in guilders/year

O = the proceeds for the energy delivered (heat and/or current) in guilders/long ton

Cost Differences

If one starts from the point of view that the processing costs must not increase ($\Delta E = 0$) then equation (1) leads to the following expression for the necessary proceeds from the energy delivered:

$$O = (\frac{\Delta V}{G} - P \times K1) \text{ per long ton of refuse}$$

or

$$O' = O \times G = (\Delta V - P \times G \times K1) \text{ per year} \quad (2)$$

If the use of primary energy by a certain energy user drops by X m^3 of natural gas and by Y kwh of electrical energy per year because of its coupling with a combustion facility, then this means a saving in the cost of primary energy by:

$$(X \times A + Y \times K1) \text{ per year} \quad (3)$$

Here A is the natural gas price in guilders/m^3 (at the present time it is 0.11 guilders for new contracts) and K1 is the kwh price for large consumers (at the present time it is 0.07 guilders). Under the assumption that the net extra operating costs of a combustion facility should be covered by the proceeds from the

sale of energy, this difference in yearly costs for an energy consumer coupled to a combustion facility is:

$$X \times A + Y \times K1 \cdot Q'$$

or

$$[X \times A + (Y + P \times G) K1 \cdot \Delta V] \; (4) \qquad (4)$$

If the result of equation (4) is positive, then the coupling results in a savings. The result of the equation, however, depends strongly on the values substituted for the variables in it.

IV-3. Cost prognosis

Any change in the costs of wages, material and fuel will strongly influence the costing picture in question. Therefore it is meaningful to analyze more closely the important cost factors according to their wage, material, capital and fuel dependent parts:

- the extra fixed costs can be indexed to wage and material costs as follows:
  $$\Delta V = \frac{1}{100} \left(28.5 \frac{L}{L_o} + 5.0 \frac{M}{M_o} + 66.5\right) \Delta V_o$$
- the following formulae (including wage, material and fuel costs) can be set up for the kwh costs:
- the kwh proceeds for energy delivered to the public network:
  (B = fuel costs) $K2 = \frac{B}{B_o} \times K2_o$
- the kwh costs for large consumers:
  $$K1 = \frac{1}{100} \left(7.1 \frac{L}{L_o} + 50 \frac{M}{M_o} + 28.8 \frac{B}{B_o} + 14.3\right) \times K1_o$$
  L = wages
- the following equation can be given for the extra net operating costs for electricity generated and for its sale to the public network:
  $$\Delta E = \frac{\Delta V_o}{100} \left(28.5 \frac{L}{L_o} + 5.0 \frac{M}{M_o} + 66.5\right) - G \left(40 \frac{K1_o}{100} \times 7.1 \frac{L}{L_o} + 50 \frac{M}{M_o} + 28.8 \frac{B}{B_o} + 14.3\right) + \left(310 \times \frac{B}{B_o} \times K2_o\right)$$

In the above formulae one has assumed that the amount of electricity consumed is 40 kwh per long ton of refuse burned in the installation and that 310 kwh per long ton can be supplied to the electricity network, if electricity is generated at the facility. By including variations in percentages of the applicable factors in the equation one can obtain a value for ΔE under one or several prognoses. One can expect that wages, materials and fuel costs will experience a rising tendency for a few more years. Over the near term one could expect, on the basis of not unreasonable assumptions, the following:

wages	10% per year
materials	5% per year
fuels	10% per year

When these percentages are substituted in the equation for ΔE, then increases in wages and material costs more than compensate for the increase in fuel costs.

For installations which must still be constructed there will be relatively higher fixed costs for energy production, using the assumptions above, than have been included in the calculation. This results from the fact that the time needed for construction, which for installations which can generate electricity is clearly longer than for those installations which can not, affects the amount of fixed costs as follows:

- a longer construction time (9-12 months) results in higher interest costs. This is an important factor, because of the present relatively high interest rates.
- a longer construction time increases the period in which increases in wages and material costs can be effective, according to the following formula:

$I = \frac{I_n}{100}\left(10 + 50\frac{L}{L_o} + 40\frac{M}{M_o}\right)$.

That these increases mentioned above are not small is apparant from the data from the CBS (Bureau of Statistics) on material and wages for the period 1 January 1973 to 1 April 1974.

	average percentage increase	
	per month	per year
steel beams	2	27
steel plate	2.6	36
copper wire	4.4	68
wages in the metal industry	1.3	17

V. Two examples of the use of the heat produced

In general, it can be said that the savings for an energy consumer who is coupled to a combustion facility are larger, the larger the role the energy costs play in the user's production costs and the more the costs of fuels will rise. In the case of electricity generation, the production costs consist of 40-50% in fuel costs. The production costs of distilled water consist of 50-60% in fuel costs. One should mention that the shipping and distribution of electricity and of water have not been included in these percentages. Moreover, these numbers are valid for production units of the normal size. The two examples of the use of the heat produced are based on a combustion facility consisting of 3 oven units, each with a capacity of 9 long tons of refuse per hour. The architectural provisions are for four units, so that expansion of the capacity is possible in a relatively simple manner.

One has taken into consideration the following cases:

A. Generation of electrical energy which is delivered to the public distribution network
B. Generation of electrical energy with the delivery of current and heat to a water plant in the vicinity.

A number of calculated results are given in Table 1. One can determine from it the following:

53E

TABLE 1

	A	B
Capacity of the combustion facility	(3+1) x 9 long t/hr	(3+1) x 9 long t/hr
Average amount of refuse burned G long t/yr	140,000	140,000
Type of turbine installation	condensation	counter-pressure
Extra investment (compared to an instal w/o the use of the heat)	f 29,100,000	f 13,100,000
Extra personnel (compared to an instal w/o the use of the heat)	19 men	15 men
Installed potential	2 x 5 MW	2 x 1,4 MW
Specific extra investment	f 2910/kW	f 4680/kW
Ave. amount of energy delivered to network	43,400,000 kWh/hr	--
Extra yearly fixed costs ΔV:		
Interest and pay-back (8 3/4%, 25 yr)	f 2,910,000	f 1,310,000
Personnel costs f 31,200/man/yr	f 594,000	f 468,000
Maintenance 3%	f 873,000	f 399,000
ΔV	f 4,377,000	f 2,177,000
Indexing coefficients for extra fixed costs		
For changes in calculation from wages	28.5%	35.3%
For changes in calculation from materials	5.0%	4.6%
Does not affect calculation	66.5%	60.1%
Proceeds and savings:		
at present-day fuel prices	f 1,260,000	
for a 50% higher price	f 1,750,000	f 2,177,000
for a 100% higher price	f 2,240,000	
Net extra costs ΔE :		
at present-day fuel prices	f 3,117,000/yr or f 22.20/ton	
for a 50% higher price	f 2,627,000/yr or f 18.80/ton	--
for a 100% higher price	f 2,137,000/yr or f 15.20/ton	
Savings in primary energy (natural gas)	14,700,000 m^3/yr	1,700,000 m^3/yr
Rise in fuel price for ΔE =0	316%	

Data on the water plant:

Average water production		2,800,000 m^3/yr
Energy consumption (without coupling)		
Primary energy (natural gas)	x'	8 m^3/m^3 of water
Electrical energy	y'	3 kWh/m^3 of water
Total amount of primary energy	(x'+0,3y')	8.9 m^3/ m3 of water
or		24,900,000 m^3 nat gas/yr
Average savings for "heat-power"coupling		
at present-day fuel prices (0.11/m^3, f 0.07/kWh)		f 0.45/m^3 of water
for a 50% higher price		f 0.95/m^3 of water
for a 100% higher price		f 1.45/m^3 of water

Resumé

Savings in primary energy (natural gas)	14,700,000 m^3/yr	26,600,000 m^3/yr

case A is for the generation of electrical energy
case B is for the generation of electrical energy with heat delivery to a water plant

- the extra fixed costs (bruto)
- the proceeds and the savings for various fuel costs
- the net extra costs of running the facility for various fuel costs
- the savings in primary energy.

From case A one can say that the waste processing costs rise considerably when fuel costs rise considerably. Figure 4 gives an idea of the kwh proceeds and of the extra processing costs as a function of the amount of waste processed. For case B there is no increase in the cost of processing refuse and there is even a savings in the water prices, but the remaining water price (about 1.50 guilders/m^3) is still high enough that the delivery of this water will be problematical. The present-day production costs for drinking water amount to about 0.50 guilders/m^3. Figure 5 gives a global picture of the production cost of distilled water and gives the cost savings that can be achieved. Seeing the rather high water price, the possibility of a combustion facility using case B is (still) not yet within reach. Delivery of heat to a city heating network has its disadvantages, since no heat is required in the summer months. During this period the flue gas must be cooled in some other fashion; this would require extra investment.

VI. Savings in primary energy

For an average heat use in the electricity production plants of about 2,300 kcal/kwh and a fueling coefficient of natural gas of 7,560 kcal/m^3, 0.3 m^3 of natural gas is needed to produce each kwh. Using the notation given in IV-2, the savings in primary energy (natural gas) when coupling an energy consumer to a combustion facility are the following:

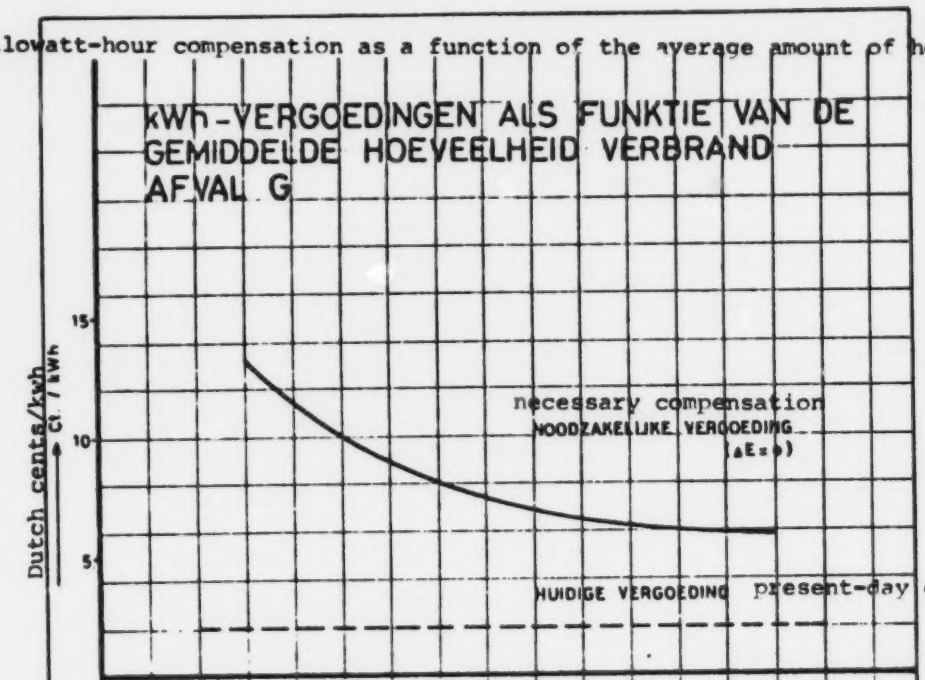
$(X + 0.3\,Y)\ m^3$

The electricity generated in a combustion facility is also used in the facility itself; this results in a further savings of about 40 kwh/ long ton of refuse or about 12 m^3 of natural gas per long ton. For the case of coupling, the total savings in natural gas can be written as:

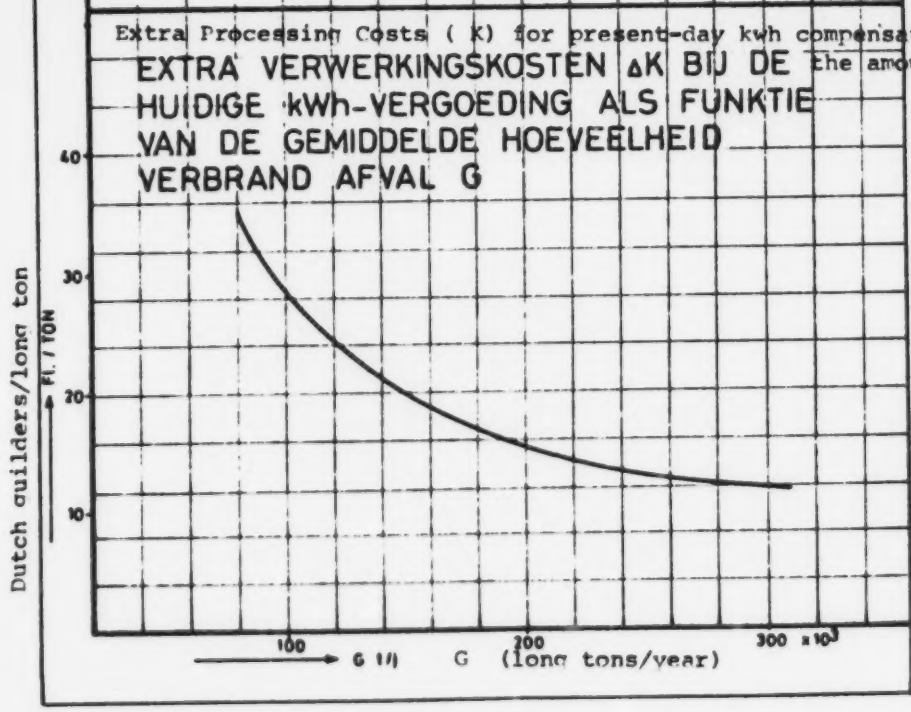
$(X + 0.3\,(Y + P \times G))\ m^3$ per year

Cases A and B show that a meaningful "heat-power" coupling of a combustion facility with a consumer results in a much larger saving in primary energy than for the delivery of electricity alone. The latter case (aside from the cost problem) is, however, for practical reasons, able to be accomplished earlier. Therefore if one is thinking of some kind of energy use, where electricity is delivered to a public network, then it appears justifiable to investigate the degree to which fuel can be saved. According to the CBS data, the following amounts of primary energy were used in the year 1972:

Kilowatt-hour compensation as a function of the average amount of household refuse burned (G)



Extra Processing Costs (K) for present-day kwh compensation as a function of the amount of refuse burned (G)



Figuur 4 Figure 4

Overall Picture of the Production Costs for Distilled Water

GLOBALE OPBOUW VAN DE PRODUKTIEKOSTEN VAN GEDESTILLEERD WATER

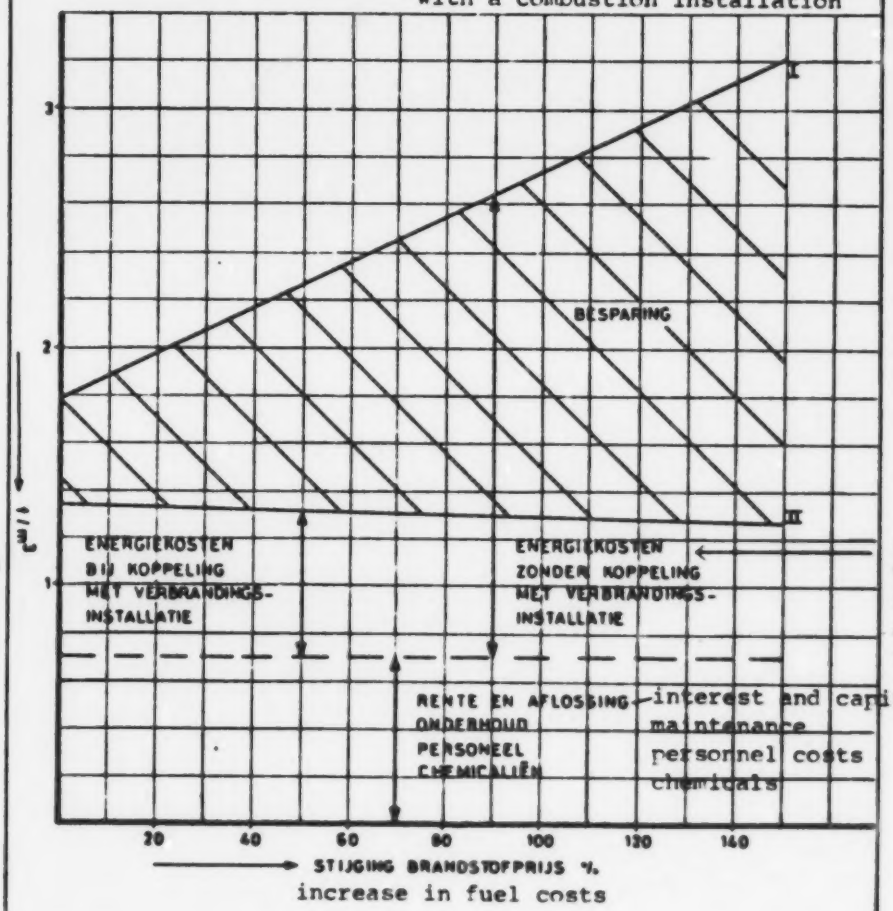
KAPACITEIT VERBRANDINGSINSTALLATIE (3 x) = 91/h — Capacity of the combustion installation

capacity of the water plant — KAPACITEIT WATERFABRIEK 3.200.000 m³/j

GEMIDDELDE PRODUKTIE WATERFABRIEK 2.800.000 m³/j — average production of the water plant

I PRODUKTIEKOSTEN GEDESTILLEERD WATER ZONDER KOPPELING MET VERBRANDINGSINSTALLATIE — production costs of distilled water without an association with a combustion installation

II PRODUKTIEKOSTEN GEDESTILLEERD WATER MET KOPPELING MET VERBRANDINGSINSTALLATIE — production costs of distilled water in association with a combustion installation



savings

energy costs in association with a combustion installation

energy costs without an association with a combustion installation

interest and capital repayment

maintenance

personnel costs

chemicals

increase in fuel costs

Figure 5 Figuur 5

coal	30,799 Tcal	
oil	310,023 Tcal	
gas	286,574 Tcal	
total	627,396 Tcal	1 Tcal = 10^9 kcal

In the near future about 1,500,000 long tons of refuse will be burned each year. By using the heat produced for the generation of electrical energy and for delivery to the public network of about 310 kwh per long ton of refuse and for an average heat consumption of 2,300 kcal/kwh, one can achieve a savings in primary energy of

1,500,000 x 310 x 2300 = 1070 Tcal per year.

At the present time about 1,000,000 long tons of refuse are burned, and the heat produced is used primarily for the generation of electricity. This is for facilities that were built about a decade ago and moreover have a large to enormous capacity. At that time as well, an alternative method of flue gas cooling (water injection) had not been sufficiently developed for application on a large scale. The relation between the extra plant costs because of the generation and the proceeds from the energy delivered to the public network has developed in an unfavourable manner. The electrical energy that might be produced in new facilities will mean a savings in primary energy, relative to the total consumption, in the magnitude of :

$$\frac{500.000 \times 310 \times 2300}{629.396 \times 10^9} \cdot 100 = 0,06\%$$

If electrical energy were to be generated in all combustion facilities, then this percentage would rise to 0.18% For case A, an extra investment of 29,100,000 guilders is necessary. From the literature one can deduce that for an investment of 3000 guilders one can insulate a one-family dwelling better so that 2375 m^3 of natural gas per year can be saved. If an amount of 29,100,000 guilders were to be invested for this purpose, a simple calculation shows that 23,000,000 m^3 can be saved per year. For the generation of electricity (case A) the savings amounted to 14,700,000 m^3 of natural gas per year. If the extra costs amounting to 2,500,000 to 3,000,000 guilders were also applied to the insulation project, then the savings calculated earlier in the amount of 23,000,000 m^3 would rise about 10% (a doubling in 7 years!). One can now come to the conclusion that, for reasons of the national economy, it is meaningful to give high priority to an increase in the efficiency of the small consumer (better insulation of homes, regular maintenance and a precise adjustment of furnaces) than to the production of energy by the combustion of refuse. One can see from the CBS data (14) that about 40% of the total use of fuels is for non-industrial application. A savings of 20% in this use is readily attainable in a short time; it is in keeping with the more than forty-fold saving which results

$$\frac{0.2 \times 40 = 44.5}{0.18}$$

from the generation of electricity in combustion facilities.

So there is a question of priority in the field of fuel saving that is quite clearly delineated.

VII. Summary

- The use of the heat released when refuse is burned results in an extra investment and associated extra (bruto) plant costs.
- one must see in what degree the savings and proceeds weigh against the extra plant costs for installation. The size of the facility plays here a not unimportant role.
- From the cases given it appears that the simultaneous delivery of electricity and heat to a consumer located nearby can have advantages over the delivery of electricity to the public network as far as the total costs are concerned as well as the savings in primary energy.
- At the present time electricity is produced from about 1,000,000 long tons of refuse per year. If, in the near future, new combustion facilities should be equipped for the generation of electricity (about 500,000 long tons of refuse per year) then 0.18% of the national need for primary energy can be contributed.
- Finally the question could be asked of whether the necessary extra investment and yearly costs might not be much more valuable in other measures which would result in savings (e.g. by the application of better thermal insulation of residential accommodation).

Nevertheless one should study more carefully, in future cases, the use of the heat produced by the combustion of refuse in such a way that the pros and cons can be weighed against each other. One should especially give adequate attention to the possibility of "heat-power" coupling. Research into the possibility of integrating the refuse processing into the total supply package (electricity + heating + warm water) should be recommended in the planning of new subdivisions or of new cities.

Heat from waste does not always have to mean waste heat.

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table 16: Basis balance for energy consumption
table 18: Electricity balance
table 19: Gas balance

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CHAPTER IV

REMOVAL OF POISONS FROM HEXAVALENT CHROMIUM USING ACTIVATED CHARCOAL

-- report of an investigation carried out by:

Dr. I. H. Anthonissen, Drs. C. J. Alsera and P. E. Poersra

Introduction

Because of its special properties, chromium and chromium compounds are used in industry for a large number of diverse purposes. Examples of these are metal refinement, oxidation processes, paint pigmenting and tanning processes. In the process of using chromium compounds, often chromium-containing refuse is produced which must be removed from society. A great deal of attention must be given especially to wastes which result in or after the use of hexavalent chromium in the form of concentrated (or not) aqueous solutions of chromic acid or dichromates. They occur in the metal surface-working industry in the form of rinsing water and concentrates. Seeing that the water managers put more and more strong controls on the hexavalent content as well as on trivalent chromium content in the waste water, the industries mentioned must take measures to remove the chromium from the waste water before it is discharged into a sewer or surface level watercourses. The measures usually consist of the installation of the so-called ONO-installations (ontgiftings- neutraliserings- en ontwateringsinstallaties --- de-poisoning, neutralizing and draining installations) in combination (or not) with ion exchangers. In the ONO installation hexavalent chromium is converted - de-poisoned - into trivalent chromium that is precipitated as chromium hydroxide in the neutralization stage. The thin mud that results is drained in a filter press, for example, until it has a dry matter content of about 30%.

The removal of poisons: consideration of the existing method

The first phase of the ONO process will be looked at more precisely here. There are some concerns on the poison removal method that has been used up to now for hexavalent chromium using sodium sulphite, ferrosulphate and, in a few cases, hydrazine. This is clear from Table II where the various poison-removal processes are given for the total ONO process on the basis of stoichiometric relations, from the redox equations (Table III), and the chemicals needed and produced.

Table II

An overview of the chemicals necessary and produced (in grams) in the ONO process of 1 kg of chromic acid and potassium bichromate using sodium bisulphite, ferrosulphate and hydrazine (24%)

TABEL II

Overzicht van benodigde en vrijkomende chemikaliën (in grammen) bij het ONO-proces van 1 kg chroomzuur resp. kaliumbichromaat m.b.v. natriumbisulfiet, ferrosulfaat en hydrazine (24%).

	CrO_3 1 kg					$K_2Cr_2O_7$ 1 kg				
	1 benodigde hoeveelheden (gr) bij ONO			2 vrijkomende hoeveelheden		1 benodigde hoeveelheden (gr) bij ONO			2 vrijkomende hoeveelheden	
toegepast reduktiemiddel	Ontgifting 3		precipitatie 4			Ontgifting		precipitatie		
	5 reduktie middel 1,20 f 3	H_2SO_4	NaOH	zout 6	hydroxide (n)	reduktie middel 1,20 f 3	H_2SO_4	NaOH	zout 6	hydroxide
1) $NaHSO_3$	1560	735	1200	3195	1030	1080	1330	822	2788	706
2) $FeSO_4.7H_2O$	8340	2940	4800	8520	4240 $Cr(OH)_3 + Fe(OH)_3$	5650	2340	3280	6100	2900 $Cr(OH)_3$ $Fe(OH)_3$
3) N_2H_4 (24%)	980	1470	1200	2130	1030	682	1230	822	3068	706

1-amounts necessary for ONO

2-amounts produced

3-de-poisoning

4-precipitate

5-reduction agent

6-salt

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8

Per kilogram of chromic acid or of potassium dichromate that is de-poisoned the following are given:

1. the amount of reduction material
2. the necessary amounts of sulphuric acid
3. the amounts of lye for the precipitation of the hydroxides
4. the amounts of hydroxide on the basis of 100% dry matter
5. the amounts of salt (salt load) in the effluent that is released.

If we bear in mind that the choice of ONO process is determined by factors such as:

1. quantitative conversion in relation to the conditions put on the discharge
2. simplicity of the process, such as the handling of chemicals
3. acid consumption during reduction
4. salt load in the effluent
5. mud yields
6. costs of the total process,

then it appears from table II that the ONO process using ferro sulphate is disappointing because of the very high salt load in the effluent and the high mud yield, unless, of course, the ferrosulphate itself is a waste -- e.g. from a staining facility.

TABLE III

Redox equations for the reduction of chromic acid (A) and potassium bichromate (B) with bisulphite, ferro and hydrazine.

A	B
$2\,CrO_3 + 3\,HSO_3^- + 3H^+ \rightarrow 2\,Cr^{+3} + 3SO_4^{2-} + 3H_2O$	$Cr_2O_7^{2-} + 3\,HSO_3^- + 5H^+ \rightarrow 2\,Cr^{+3} + 3SO_4^{2-} + 4H_2O$
$CrO_3 + 3Fe^{2+} + 6H^+ \rightarrow Cr^{+3} + 3Fe^{3+} + 3H_2O$	$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2\,Cr^{+3} + 6Fe^{+3} + 7H_2O$
$4\,CrO_3 + 3N_2H_4 + 12H^+ \rightarrow 4\,Cr^{+3} + 12H_2O + 3N_2\uparrow$	$2Cr_2O_7^{2-} + 3N_2H_4 + 16H^+ \rightarrow 4Cr^{+3} + 14H_2O + 3N_2\uparrow$

The ONO process using hydrazine appears to be attractive because of the relatively low salt load but it is difficult to handle. Thus bisulphite remains as the only reduction means. The de-poisoning with bisulphite - or other SO_2 donors - is the most commonly used. The use of bisulphite also has its drawbacks because one, in fact, delivers another waste, in this process, to the effluent -- namely the sodium sulphate from the oxidation of sodium bisulphite. In practice it appears that for the ONO process for rinsing water containing hexavalent chromium, appreciably more bisulphite is necessary than that amount calculated stoichiometrically. In general it can be said that a high acid consumption - see table II - is favourable during the reduction seeing that then there is a lower lye consumption during the neutralization. From the above one can see that the de-poisoning method determines the cost of the total ONO process.

De- poisoning using activated charcoal

One of the routine laboratory activities of the SVA is the determination of the so-called percentage of degradables (organic matter) in the combustion residue of urban refuse and similar refuse. From an investigation into the origin of the differences occurring in the results between the three methods (EAWAG, where the degradable part in the slag oxidizes with bichromate; EMPA, where the degradable part in the slag is extracted with lye; TÜV, where the degradable part in the slag is extracted also with lye and the extract is then oxidized to carbonic acid using permanganate) which exist for the degradability determination, it appears that the presence of carbon in the not completely combusted slag is responsible for the differences. The carbon (not biologically degradable!) is oxidized along with the bichromate. In the literature some mention is made of an interference by carbon in the regeneration of chromic acid solutions with ion exchangers using activated charcoal (1) and of four applications of the reduction of hexavalent chromium by carbon (2,3,4,5) where the non-solubility of the chromium-containing waste after heating with activated charcoal at 400-700°C is, in that case,the most interesting part (6). Because of the already mentioned objections to the de-poisoning of hexavalent chromium with bisulphite, ferrosulphate and hydrazine it seems meaningful to look at the degree to which carbon, in whatever form, could be used as a reduction means for concentrates and rinse waters containing hexavalent chromium. During the investigation it appeared that cokes, powdered carbon and lignite almost never reacted with a dichromate-sulphuric acid mixture at room temperature. Reductions occurred only after an extensive heating period. Seeing that this type of carbon is not usable in an OWO process, the investigation was continued using only activated charcoal. As the first experiment with activated charcoal, an acidic Cr^{VI} solution with a normality of 0,25 was cooked with activated charcoal in powder form. The course of the reaction could be followed by watching the colour change from orange to green to blue. After a few minutes one could detect no Cr^{VI} using a Merckoquant chromate test paper. These tests were repeated at various temperatures. The following picture can be made from the results: Cr^{VI}-containing liquids enter into the pores of the activated charcoal where the Cr^{VI} (from chromic acid or dichromate) is quickly absorbed. This reacts somewhat more slowly with the carbon producing Cr^{III} and carbonic acid (CO_2). Because of the gas the liquid is pushed out of the pores with the result that the reaction stops until the CO_2 is removed. The removal, out of the carbon of the CO_2 is therefore the phase that determines the speed and is therefore a determining factor for the macroscopic reaction speed. The reaction speed increases with increasing temperature, Cr^{VI} concentration and increasing amount of activated charcoal (see figure 6).

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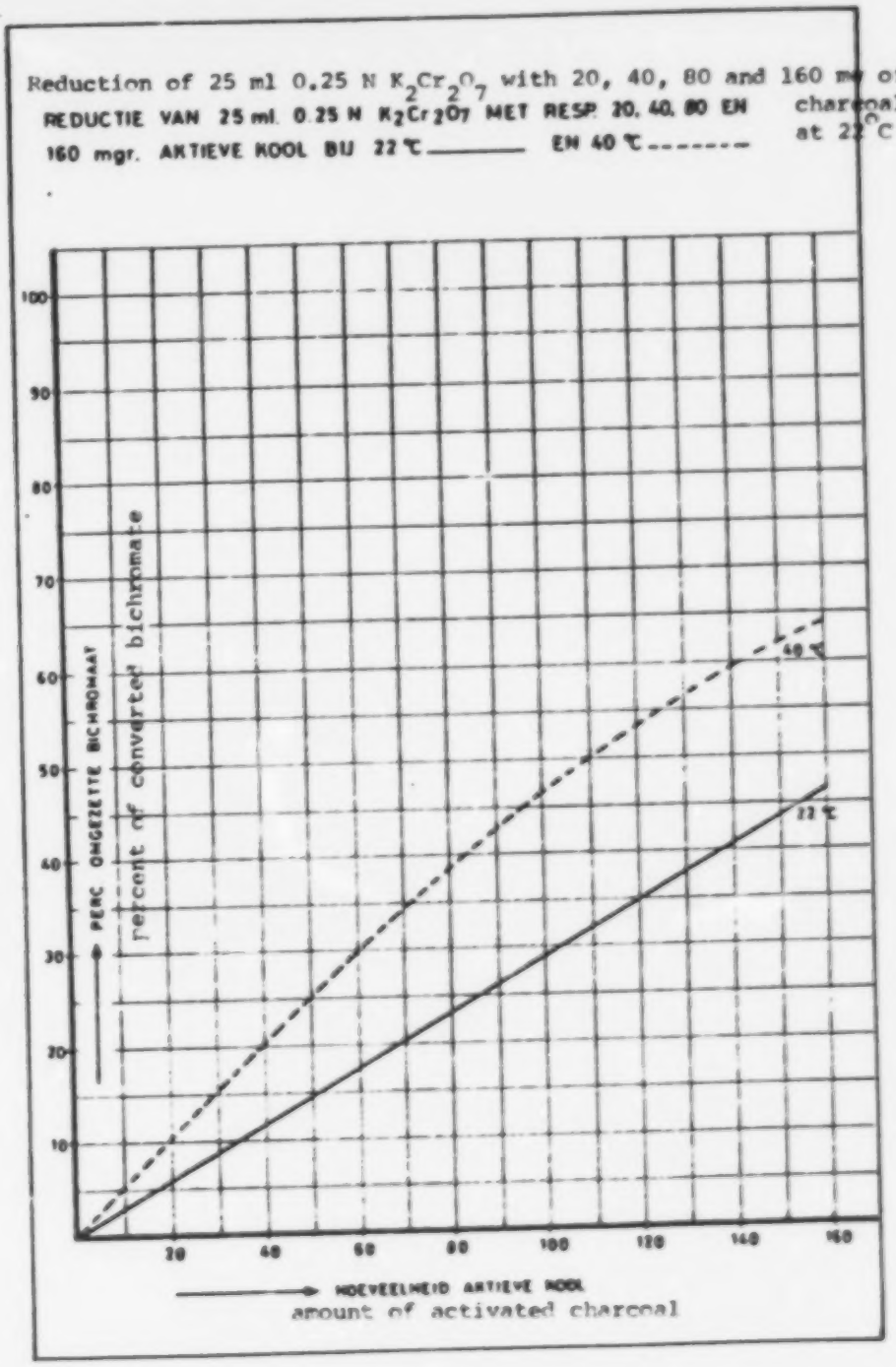


Reduction of 25 ml 0.25 N $K_2Cr_2O_7$ with 20, 40, 80 and 160 mg of activated charcoal respectively at 22 °C and at 40 °C

Figuur 6 Figure 6

Instead of dumping the activated charcoal into the Cr^{VI} solution (which would inhibit the CO_2 removal) one can increase the reaction speed (i.e. shorten the reaction time) by using an activated charcoal column; an acidic Cr^{VI} solution is dripped onto the moistened granulated activated charcoal (from which the air also has been removed). The CO_2 produced in the reduction process can now directly escape into the air so that the carbon surface always remains accessible for the reaction. An advantage is also that the dosing of the Cr^{VI} solution occurs in such a way that a liquid mirror does not appear in the column.

The column tests

The PVC column (see figure 7) with a length of about 1 m and a diameter of about 4 cm was enlarged at the bottom to form a sieve of 10 cm in diameter. The total content was about 2 litre. The load consisted of 800 g of activated charcoal, Norit PKST quality. The chromic acid solutions reduced in this column were of widely variable concentrations - namely from 40 mg (the concentration in rinsing water, for example) to 4 g and 40 g of chromic acid per litre. It appeared that concentrations higher than 40 g of chromic acid per litre resulted in a too great heat production. It may be possible then that the way to reduce highly concentrated solutions is to add them to the activated charcoal; otherwise one must dilute them. The dripping speed of the chromic acid out of the storage vat was set up in such a way that:

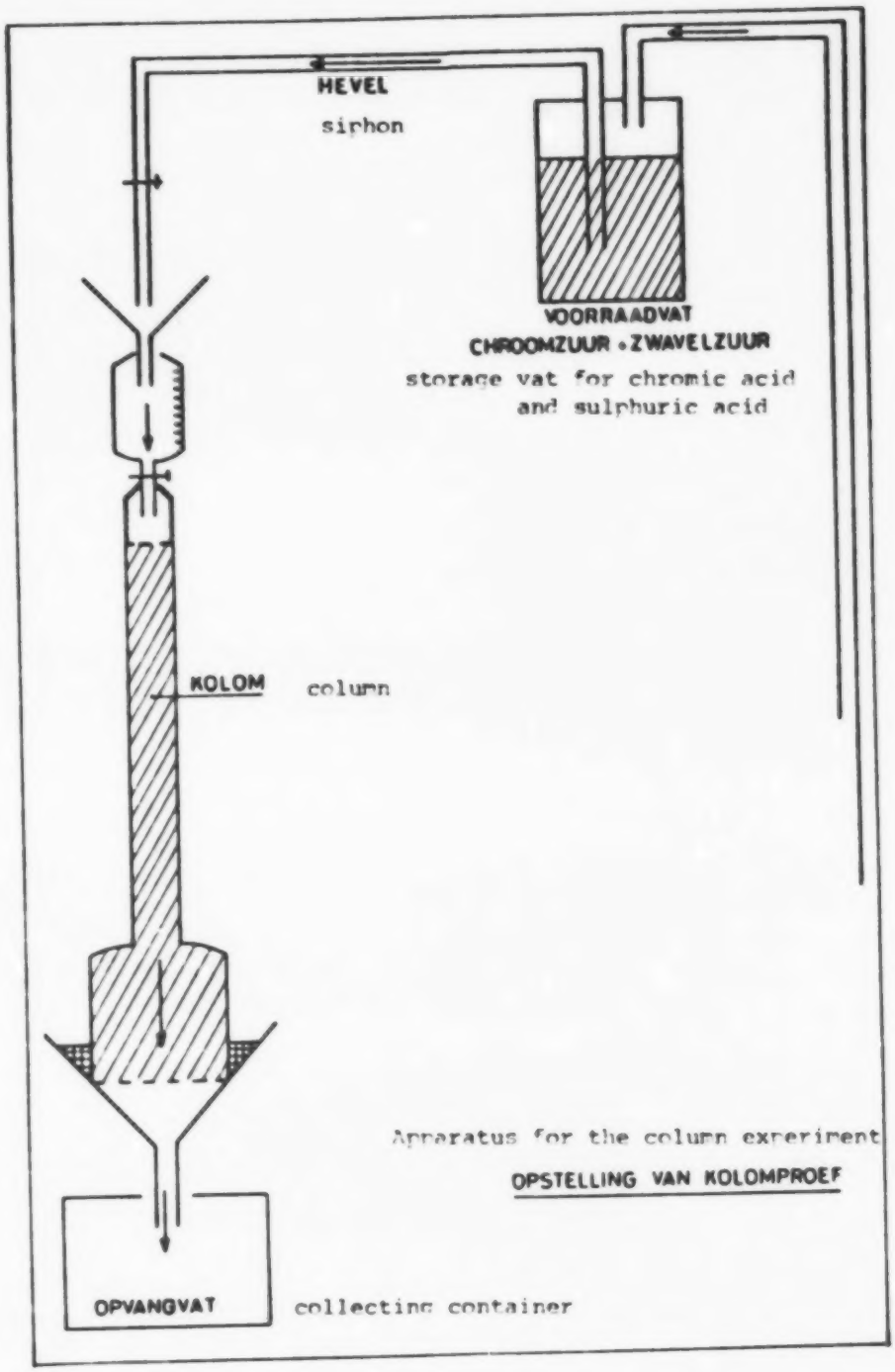
1. the eluate produced contained no Cr^{VI}
2. no liquid mirror appeared.

For the lowest concentration (40 mg per litre) about 30 l/hr could be dripped in this way, for the middle concentration about 2 l/hr and for the highest concentration about 1 l/hr.

Table IV gives an overview of the results of the reduction.

TABLE IV

		A			B
Chromic acid concentration gr/litre	Amount of activated charcoal	Amount of chromic acid reduced	Amount of activated charcoal needed in theory per kg of chromic acid	Amount of activated charcoal necessary in practice per kg of chromic acid	Ratio of the amount needed in theory to the amount used in %
4	800	1150	90	700	13
40	800	800		1000	9
4	80	110		730	12



Figuur 7 Figure 7

The following are given in Table IV:

a. the amount of chromic acid in concentrations of 4 and 40 g/l completely reduced by 800 g of activated charcoal.

b. the amount of chromic acid in a concentration of 4 g/l completely reduced by 80 g of activated charcoal in a smaller column of 160 cm length and of 1.1 cm in diameter; this was to give an idea of the influence of the column diameter.

c. the conversion percentage of the activated charcoal according to the ratio of the amount of activated charcoal necessary for the reduction of 1 kg of chromic acid (using the redox equation below) and the corresponding value in practice.

$$4CrO_3 + 3C + 12H^+ \rightarrow 4Cr^{3+} + 6H_2O + 3CO_2$$

NB 1.

The amounts reported under A (in table IV) relate to a 100% reduction of chromic acid. The eluate from the column was continually tested using Merckoquant chromate test paper for the amount of Cr^{VI}.

NB 2.

The amounts reported under A do not take account of the fact that the column may have been exhausted. It does appear that activated charcoal keeps reducing for a long time, in spite of the decreasing effectiveness. This means that the total capacity (total conversion percentage) of the column is higher than the value given under B.

NB 3.

As mentioned earlier, a de-poisoning test for one hour was done with the lowest concentration solution (40 mg/l of chromic acid). The optimal flow speed for this column was about 30 l/hr.

NB 4.

The influence of other ions such as iron, copper and nickel on the reduction was not looked into.

Comments on the test results of table IV

In comparison with the existing methods, the de-poisoning of hexavalent chromium using activated charcoal columns offers possible advantages. With respect to the earlier 6 criteria, it can be said that:

1. the process of reduction is very simple
2. the dosing, insofar as it may be a problem, might require some dilution. In practice, the existing methods always need some dilution in the succeeding phases of the CWO process (neutralizing and draining)
3. no extra salt load occurs (disadvantage of bisulphate)
4. for an increase in the scale in practice, more insight into the process can be

obtained on the optimalization and the costs of the process. It appears that a series of columns is favourable since the columns gradually become exhausted.

Further Investigation

The fact that only activated charcoal reacts quickly with chromic acid indicates that the effective area is a determining factor for the good operation of the reaction. One should look at the charcoal at the exit and at the amount exhausted for:

a. area

b. quality of that surface for the functional groups

c. the adsorption of metals onto the charcoal during reduction

d. possible regeneration of the charcoal used.

Conclusion

It is possible to de-poison quickly, simply and quantitatively rinsing waters, containing hexavalent chromium and chromic acid concentrates using activated charcoal columns. As far as the existing methods are concerned, such as de-poisoning with ferrosulphate or sodium bisulphate, this method has the advantage that the dosing problem is not present and that no extra salt is delivered to the discharge water. Optimalization and increase in scale of the de-poisoning process to a laboratory scale will indicate whether it is possible to introduce into practice this new de-poisoning method (possibly in combination with a cation exchanger), for instance in plants which do not have a complete ORO installation at their disposal.

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CHAPTER V

THE COMBINED PROCESSING OF PURIFICATION MUD AND SOLID WASTES

-- a lecture by Ir. T. Teeuwen

1. Introduction

From the point of view of the sewage water purification plant, purification mud is refuse and it leaves the plant - if it is to undergo no further processing - with a very high water content (94-96%). Only rarely are the conditions such that the mud is carried away in this form without further treatment. Usually there is a further treatment where the mud is pasteurized, dried and drained. Still, even in the dried or drained form, the removal of the mud becomes a greater and greater problem as the size of the purification installation increases. In certain aspects the problems associated with mud processing are the same as those associated with the removal of solid refuse and it is meaningful therefore to see if there are prospects for the combined removal of both types of refuse. Before looking at the combined processing of mud and other waste, I will give first an overview of the various types of refuse that we can distinguish. The various categories are given in figure 8. Next to the category, purification mud (F), the following categories are of interest as solid wastes which might be possible to process in some type of combination: urban refuse (A), industrial refuse (B), construction and wrecking rubbish (F). For this report one understands that by purification mud one means mud which results from the purification of household and similar types of industrial waste water. Mud coming from waste water which has a high content of toxic matter, which can not (or may not) be purified together with household waste water, is not considered here. It can be imagined that the disposal of the categories of purification mud and urban refuse have a few similarities, namely:

1. these wastes are produced in roughly the same proportion because they are related principally to the number of inhabitants.
2. they are wastes that usually are not collected and processed by private interests, but for which the local administration is responsible, in either a municipal or intermunicipal sense.

In practice, the possibility of combined processing is not always taken advantage of even though it would be desirable. In figure 9 the disposal methods for mud, possible in practice, after it has been treated in a purification installation are given. This pre-treatment consists of a more-or-less extensive draining. The figure shows how, depending on the degree of draining, a number of combinations of mud and solid waste processing could be imagined. My purpose in this report is to show whether and under what conditions the given combinations are practical to carry out, taking into account the conditions in the Netherlands.

In general the method of solid waste disposal determines, in principle, whether and in what form the mud can be processed in combination with it. Then the possibility of combined combined processing is treated, starting from the following 3 processing methods for solid refuse:

- composting
- controlled dumping
- combustion.

It can be said that, in principle, mud can be processed by each of these methods, but certain conditions must be placed on the pre-treatment before this combined processing is technically possible and justifiable on grounds of environmental hygiene.

2. Mud processing in combination with the preparation of compost

In the Netherlands in the years 1965-68 much research took place on the possibility of composting mud together with urban refuse. Ir. B. Teensma published (1) an extensive report in 1968 on the results of this research. On the basis of these results, the following can be said for the present-day conditions:

1. a humidity content of about 55% for pulverized urban refuse is necessary for an optimally operating aerobic fermentation to occur. To achieve this water is added. Instead of water one could use liquid sewage mud as well. Considering that 250 kg of household refuse with a humidity content of 30% is produced per inhabitant, about 150 l of water must be added. If one uses wet mud instead of that, and if one only considered free water, then this means that about 30% of the total amount of mud produced (excluding industrial mud) could be processed in this way. In order to be able to process, in this way, equivalent amounts of urban refuse and mud, the mud must be drained to a more solid consistency.

2. for experiments it appears that, in the composting of urban refuse using the Van Maanen system, solid sewage mud can be added without difficulty in a weight ratio of 1 part of unpulverized urban refuse to 1 part of solid sewage mud. In the Van Maanen system the refuse is fermented in the unpulverized state in piles of from 6-10 m in height. The fermentation time is 6-8 months and during this period the mixture is restacked two times.

Although the above results have been obtained in tests, the combined processing of mud and composting is not applied on a large scale in the Netherlands. In fact there is only one composting plant which treats household refuse (unpulverized) and vacuum-dried mud in a combined composting. This is the composting plant in Nierlo that composts using the Van Maanen system. In 1970 about 38,000 long tons of compostible household refuse and 17,000 long tons of mud (20% dry matter) were treated. The mud comes from a nearby mud filtering installation of the purification facility of Eindhoven. It is brought by wheeled transport to the composting plant and there

CATEGORIES OF WASTES

A. URBAN REFUSE -- household refuse, coarse refuse, garden, market and street waste, and waste from small businesses

B. INDUSTRIAL REFUSE -- light wastes, such as packing material, paper, synthetics and remainders

C. REFUSE FROM THE AGRARIAN INDUSTRY -- agriculture, horticulture, market auctions

D. REFUSE FROM THE BIO-INDUSTRY -- fertilizer plants, stock raising and slaughterhouses

E. MUD FROM PURIFICATION INSTALLATIONS -- household waste water and similar kinds of industrial waste water

F. CONSTRUCTION AND WRECKING RUBBISH (FROM URBAN AREAS AND INDUSTRY) -- rubbish, earth, heavy wastes from industry, waste from re-organizations

G. WASTES WHICH ARE DIFFICULT TO PROCESS (CHEMICAL) - (SOLID, SEMI-SOLID AND LIQUID) -- chemical and petrochemical industry, laboratoria, users of chemicals, oil products, paints, cleaning materials, dipping baths

H. JUNKED CARS, ETC.

I. MISCELLANEOUS -- nuclear wastes, material to be destroyed, contaminated wastes, hospital wastes

Figure 8

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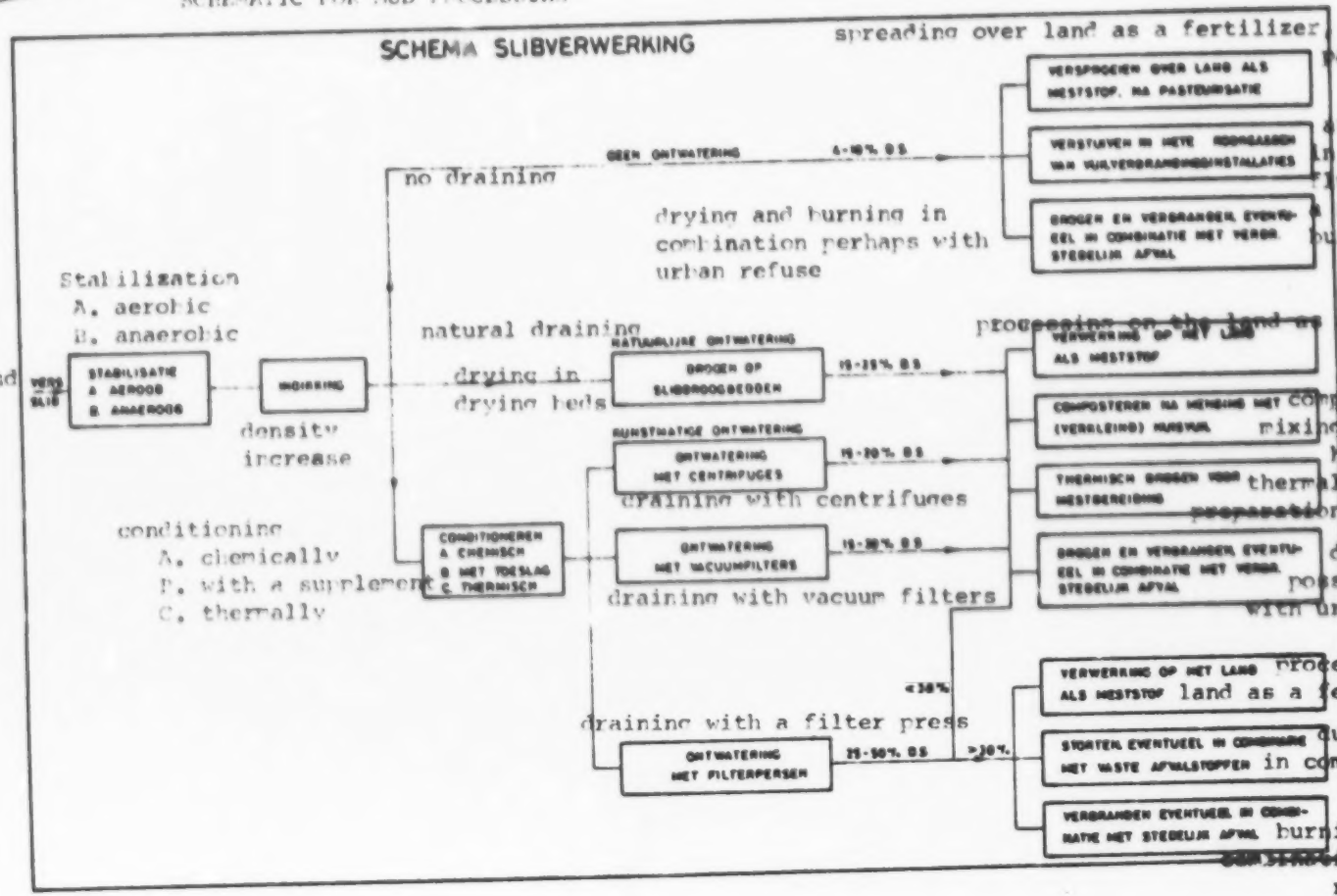
SCHEMATIC FOR MUD PROCESSING

Figuur 8



spreading over land as a fertilizer after pasteurization

atomization in the hot flue gases of a refuse combustion facil.

processing on the land as a fertilizer

composting after mixing with pulverized household refuse

thermal drying as a preparation for fertilizer

drying and burning possibly in combination with urban refuse

processing on the land as a fertilizer

dumping possibly in combination with solid waste

burning possibly in combination with urban refuse

with the help of manure spreaders is thrown onto the piles of household refuse to be composted. Seeing the situation in the Netherlands, it does not appear that the mud processing in combination with composting will measurably increase in the future, with the exception perhaps of the plant in Nierlo, since still more mud will be delivered from the future expansion of the purification installation in Eindhoven. Mud processing in combination with composting in municipal composting plants, using the pulberizing principle, is no longer possible in the Netherlands. Because of the more difficult maintenance of compost quality and the increased demand for dumping space for residues and non-compostible refuse, the plants are being closed down one by one. From the original 15 plants using the DANO and BASF systems, there remain only three. The difficulties, which the municipal composting plants experience, are also present to a lesser degree in the VAM plants; since the refuse here is not pulverized beforehand a better quality control is possible. On the other hand there is sufficient dumping space at these plants for a cheap processing of the non-compostible wastes. For what the need for compost is, the following can be said. There has been a shift in the last ten years from the agricultural sector to the horticultural sector in the direction of recreation and ornamental gardens. The compost is usually sold as an enhancing compost and a gardening compost of high quality which produces good results. It does not appear likely that the use of compost in the future in agriculture will show much increase. Because of the large increase in the bio-industry and in mushroom cultivation, of the intensive and extensive foodstuffs industry (sugar, potato meal, cocoa) and of the expansion of the number of purification installations there is already an enormous increase in the amount of organic matter which appears as waste (e.g. manure, mushroom manure, scum, cocoa nut waste and mud). This matter gives rise to so many problems - in spite of its suitability, more or less, as soil structure improverent material or as fertilizer - in its disposal (in agriculture) that the production on a large scale of still one more organic substance as compost is unimaginable as far as the agricultural sector is concerned.

3. Mud processing in combination with controlled dumping

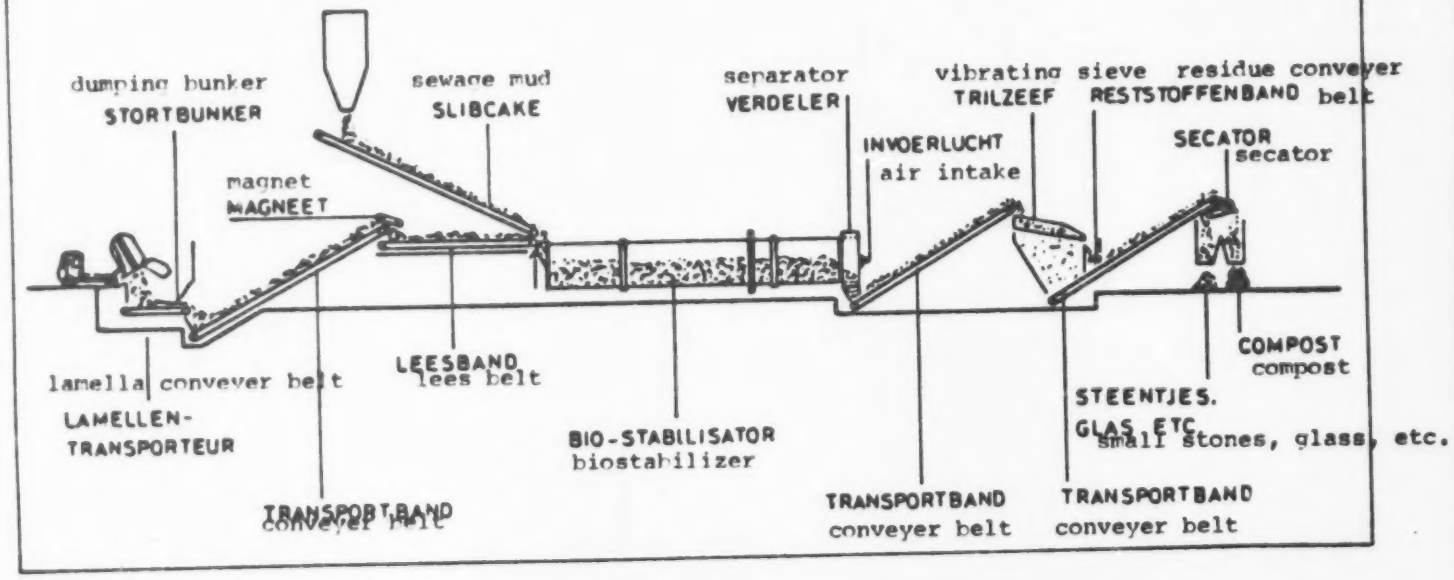
The controlled dumping of refuse, in contrast to the uncontrolled dumping, such as is done in practice with about 60% of our solid refuse, is an improved method of dumping where the greatest amount of attention can be put on a processing which is responsible both on esthetic and environmental hygenic grounds. The method requires a relatively small investment since it can occur at not too great a distance from the point where the refuse is produced. A good working method requires that the refuse be brought to the site in small quantities in such a way that it can be processed, pressed and covered in a continuous fashion. For the daily covering a large amount of covering soil is necessary (about 25% of the volume of dumped refuse).

Figuur 10

Figure 10

SCHEMA:
GEZAMELIJK COMPOSTEREN VAN HUISHOUDELIJK AFVAL EN ONTWATERD RIOOLSLIB VOLGENS DANO-SYSTEEM

Schematic: Combined de-composition of household refuse and de-watered sewage mud using the Dano system



In order to prevent any water or soil pollution, good water management is of prime importance on and under the dumping site. Depending on the condition of the soil it is necessary, at certain dumping sites, to completely isolate the dumping site, as far as the water is concerned, from the neighbourhood by bringing about a soil barrier, drainage, a surrounding ditch and water purification. Before beginning with the dumping project, one should know more accurately by study and investigation at the site (i.e. soil scientific and geohydrological investigations) which of the measures mentioned should be considered for application. It is not so much a question of the organic pollution as of the inorganic matter in the form of soluble minerals, salts and metals which occur more and more frequently in the percolation water. The behaviour of them in the soil, especially under anaerobic conditions and in combination with organic matter, is not very well known. Much research is still necessary on this point. As far as the disposal of wet mud to controlled dumping sites is concerned, there is still no experience on a practical scale in the Netherlands. In general the supporters of controlled dumping are very apprehensive about this, especially when the fresh mud has a dry matter content of about 5%. The arguments are:

1. strong increase in the amount of percolation water
2. because of it, stronger leaching out of the dumped refuse and an increase in the ground water pollution.
3. one can not maintain the operating conditions of controlled dumping (layer thickness of 2 m, daily covering, small dumping surface, etc.) in practice, if large amounts of liquids are discharged.

We must take into consideration that - on a yearly basis - per inhabitant - about 300 kg of urban refuse (of which about 250 kg consists of household refuse and 50 kg of small business refuse) and about 700 l of fresh mud are produced. A preliminary investigation on a small scale has shown that in this weight ratio it is not possible to carry out a combined processing at a dumping site. The research took place at the VAM plant in Vlister, using unpulverized urban refuse. The test was carried out with, besides sewage mud, thinned manure originating from stock raising activities (bio-industry). The conclusions of the investigation that took place in 1972 were:

1. to a certain degree it is possible to process wet mud with fresh refuse if the following working method is followed: first the fresh refuse is set out in rows (ridges, dikes) with a height of about 1.5 m. Mud is pumped between these rows and directly afterward the household refuse ridges are levelled in such a way that the mud disappears completely under the household refuse. The ratio in which thin mud can be processed with urban refuse in this way without seriously

affecting the traversability of the dumping site is about 1:1

2. the combined processing of mud with refuse requires higher standards on the organization especially on the discipline of the personnel.
3. the amount of percolation water that occurs rises measurably (during the investigation by a factor of 10!). Refer to page 40 of the 1972 annual report. A water nuisance will probably occur at any sides of the dumping site which have been built up.
4. the method will only be applicable when the amount of solid refuse originating from a larger number of inhabitants is processed with mud from a smaller number (i.e. relatively large dumping site in combination with small sewage water purification installations).

There will probably be a strong anaerobic fermentation at the dumping site with the possibility of a serious odour and gas (methane) problem. The final conclusion is that the processing of thin mud at a controlled dumping site, especially because of the associated organizing problem, is only incidently possible. A great difficulty is the digging of trenches and the transportation of the mud by movable hoses. Further research could show, in a practical scale, how much mud in ratio to the solid refuse can be accepted at a controlled dumping site - where the dumping is done in layers. It can be assumed that in certain cases, for instance because of a high water table or a local strong landscaping-esthetic reason (daily covering), no fresh mud could be accepted.

An investigation was started in 1973 with [illegible] on various types of mud with a higher dry matter content. The purpose of the investigation was to determine the amount of dry matter content that had to be achieved before the mud could be processed at a controlled dumping site in such a way that no disturbance was done to the working procedure. One looked first at mud with a dry matter content of about 15%. This was a chemically conditioned mud, drained using a sieving press. The mud was processed in a weight ratio of 1 part of mud to 2 parts of solid refuse. The result of the investigation, which took place at the controlled dumping site of the West Friesland Co-operative Organization (West-Friesland Samenwerkingsorgaan) was not satisfactory. The mixing of the mud with refuse required so much time that the bulldozer could no longer handle the amount of refuse delivered and a stagnation of the normal dumping activity took place. Then the humidity in the mud was not absorbed by the refuse; the mud/refuse mixture acted like a gelatinous mass. Because the bulldozer, during the procedure, pressed the mud up, it stuck to the wheels of the collecting vehicles. When one looked at a mud with a higher dry matter content, varying between 18 and 25%, originating from a mud-drying bed, the results were not much better. The investigation will be continued with mud with a dry matter content

about 25%, originating from a vacuum filter. The expectation is that the processing of this mud will not be much better. This is the situation for the processing of mud at a controlled dumping site where one attempts a high compaction of the refuse. One method which is used in Germany is the mixing of mud in a hammering mill where the refuse is pulverized before it is dumped using a rotting-dump (Rotte-deponie) method. In this method the refuse undergoes a fermentation before it is definitely buried in the ground. In the literature there is an indication that equivalent quantities of pulverized refuse and wet mud can be processed in this way using the rotting dump method (2). This was not restricted only to household refuse but pulverized coarse refuse and industrial wastes were used as well; here the average humidity was only about 10%. One can not usually count on such a low humidity content. Maximum weight ratio of 1 part of pulverized household refuse to 2 parts of solid mud could be processed in an investigation at the composting facility in Arnhem where solid mud was added to freshly pulverized household refuse. In this way it was still possible to obtain a reasonable fermentation of the mixture.

4. Mud processing in combination with combustion

One of the great advantages of the combustion method is that is makes possible a quick isomeric transformation from urban and other similar industrial wastes in such a way that the weight is about 30% and the volume is about 7% of the original weight and volume respectively. Because the combustion method is a relatively expensive method, where only for the processing of large quantities (50-60,000 tons/yr) can the costs be brought to a reasonable level, it is chiefly used in areas with large population concentrations and where dumping within a certain radius is not possible. Before treating the problem of processing mud, I will first mention the most important requirements that must be put on a modern combustion facility:

1. the whole process of filling combustion and removal of slag must be done mechanically (no personal handling) and in a continuous fashion.
2. the combustion must be done using an reliable technical furnace installation for which care must be taken for a good evaporation of the humidity present in the refuse, for the gasifying of volatile combustible matter and for post-combustion of the remaining solid carbon.
3. there should be a large hearth volume available for a good combustion of gases that are poor in their energy content, by maintaining a temperature of about 900°C. Below a temperature of about 750°C it appears that odourous contents of the gases are not removed; under no conditions must this temperature be lowered.
4. the combusted gases must be cooled to a temperature of about 300°C so that the cleansing of the gas is possible using the appropriate apparatus. The flue gases

have the property that they can result in corrosion of the conducting tubes below a temperature of about 250°C because of their being below the dew point for the gas. In this regard the gases of refuse combustion are especially aggressive.

5. cleansing of gases of fly ash, sand and matter. The best way of gas cleansing is with an electrostatic filter which because of the property of the material used works best at a gas temperature of 350°C maximum. A good gas cleansing can also take place by using a washing installation (scrubber). This has its effect below the dew point so that corrosion problems can be expected if one does not use very expensive materials and/or material plating (e.g. plating with lead, enamel or heat-resistant synthetics). The chimney must also in this case be constructed of an acid resistant material.

Many methods have been developed for handling mud in one form or another together with the combustion of solid refuse. The various methods use very different attacks; in some cases no pre-draining of the mud occurs, in others it is drained to a dry matter content of 50%.

a. Combinations with wet mud

The most interesting combination from the heat-economy point of view is the one in which the heat which is released in the combustion of solid refuse is used as much as possible for the thermal drying of wet mud. With this method it is, in principle, possible to dry and to burn the total equivalent amount of mud. One of the first methods developed is the one in which the wet mud, without any mechanical draining, is mixed with combustible household refuse. The mixture of mud and pulverized refuse is first dried and then burned. Here the use of a multi-stage oven is familiar; the mixture of mud and pulverized refuse is dried in the upper levels and after drying is burned in the lower levels. The principle of the oven is shown in figure 11. The combustion gases flow in the opposite direction from below to above throught the installation and in this way a heat exchange takes place in which the gases are cooled from about 900°C to 300-400°C, depending on the amount and on the humidity content of the mud. The installation in Leipzig (Germany) and Dübendorf (Switzerland) use this method. Not all of these systems work with wet mud. The installation in Leipzig uses a mechanical pre-draining using centrifuges; this is not the case in Dubendorf. A better process for the system takes place in Bühlach (Switzerland). One uses there also wet non-pre-drained mud; the solid refuse is pulverized as well although it is not mixed with wet mud. The mud is dried separately in the uppermost levels (figure 12). The pulverized solid refuse is then added to the lower levels in the oven and then burned together with the dried mud. The difficulty of mixing the pulverized refuse and mud into a homogeneous mixture is avoided in this method; this improves the continuity and regular operation of the

Processing of purification mud in combination with pulverized household refuse in a multi-stage oven (Bülach system)

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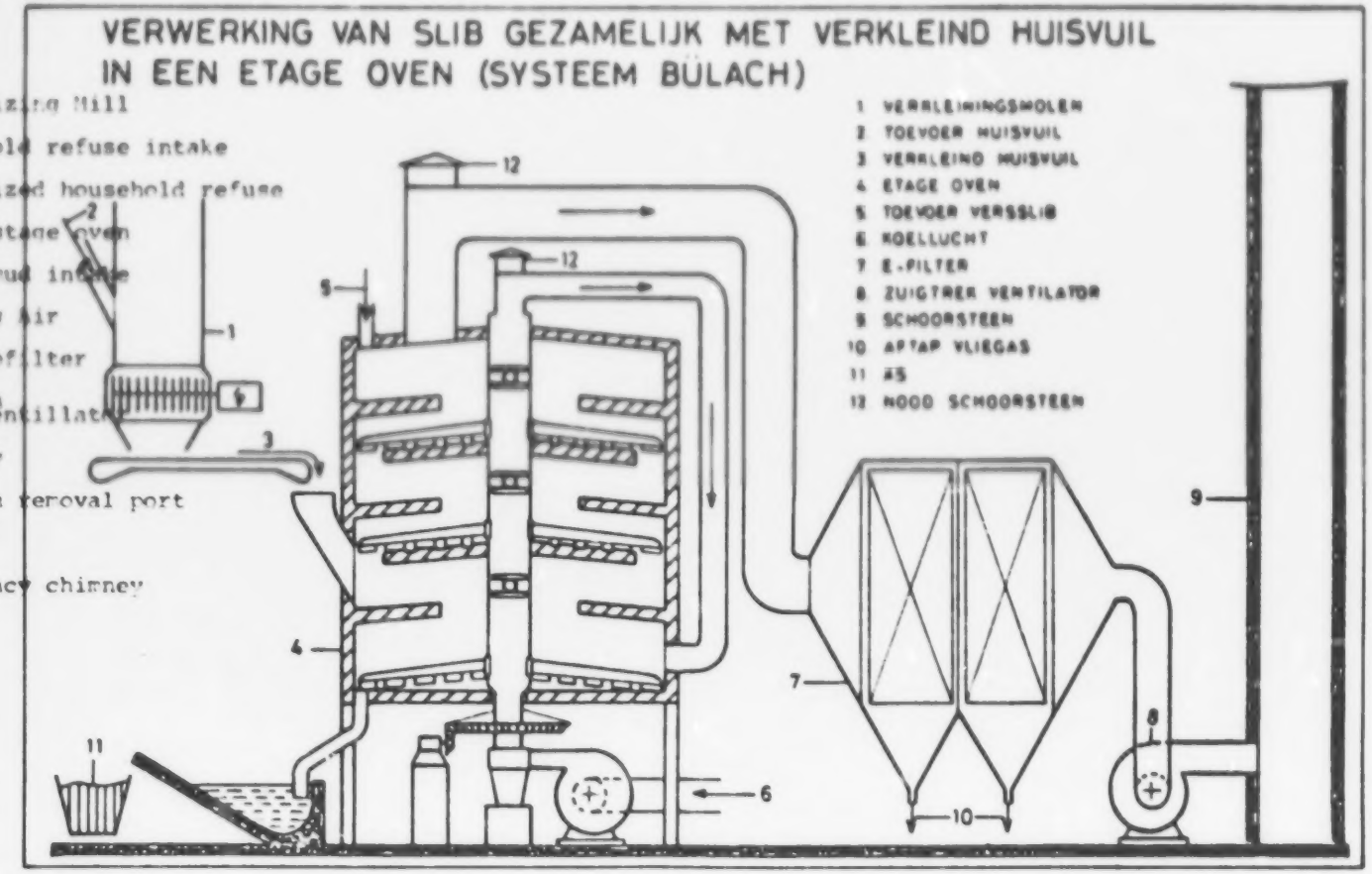
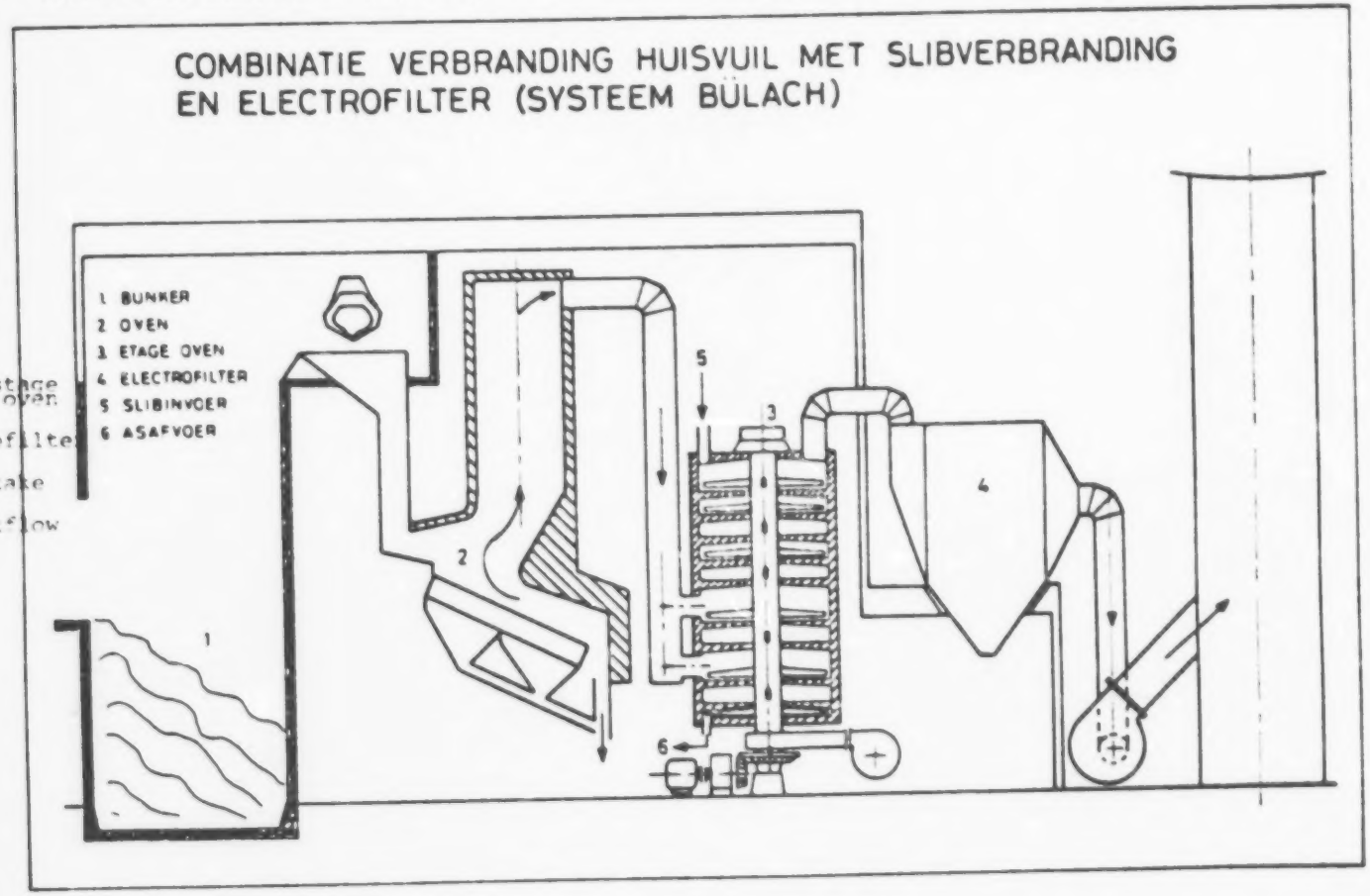


1. Pulverizing Mill
2. Household refuse intake
3. Pulverized household refuse
4. Multi-stage oven
5. Fresh mud intake
6. Cooling air
7. Electrofilter
8. Suction ventillator
9. Chimney
10. Fly ash removal port
11. Ash
12. Emergency chimney

Figuur 11

Figure 12

Combined Combustion of Household Refuse with Purification Mud Combustion and Electrofilter (Bülach system)



1. Bunker
2. Oven
3. Multi-stage oven
4. Electrofilte
5. Mud Intake
6. Ash Outflow

8

8C-

drying process as well as of the combustion process. In my opinion one can recommend the processing of mud by combustion with wastes, in all combinations, by using anaerobic or aerobic mud instead of fresh mud, for the following reasons:

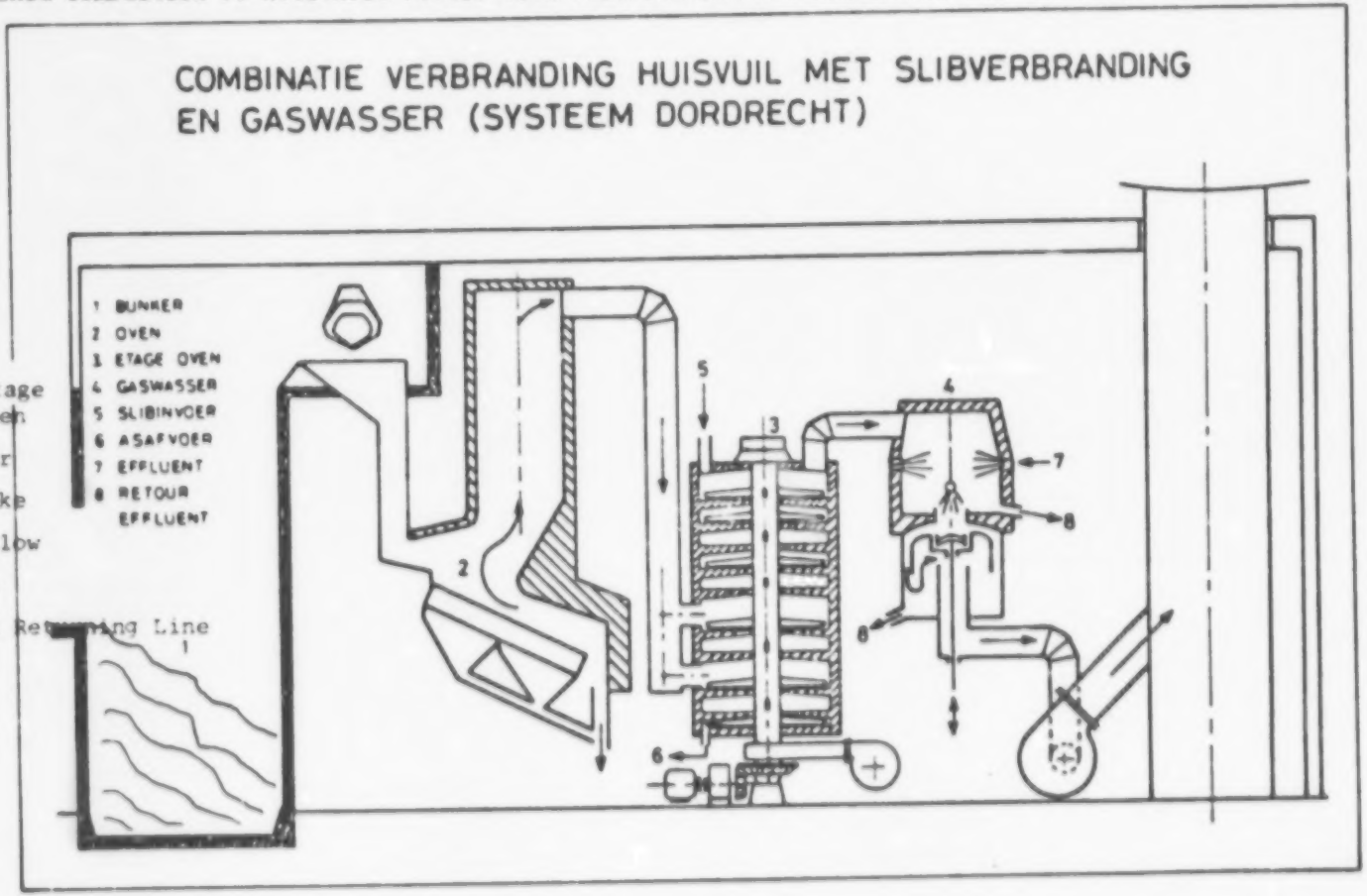
- if any shutdown should occur in the combustion facility or in the delivery of refuse to the facility there is always a certain buffer capacity present.
- the composition and the properties of the mud are highly improved, the mud is more homogeneous, the combustion properties are more constant, it has a less unpleasant odour, it does not attract any flies during temporary storage.
- the amount of mud is decreased by 30-40% so that the amount of water to be evaporated is reduced to the same degree. This increases the plant's reliability, when combined with refuse combustion since because of the nature of the solid wastes, the combustion process can undergo serious fluctuations. Then there is a surplus of heat rather than a shortage; this is advantageous for the continuity of the mud processing. It is true that the lowest fueling value of stabilized mud is about one-half a great as that of fresh mud but this has relatively little significance for this process.

A newer application of the combined system has been carried out, in the meantime, in Dordrecht (figure 13). Here solid refuse is not burned together with mud in a multistage oven but in a separate combustion oven, specially designed for this purpose. In this case it is not necessary to pulverize and to remove the iron from the solid waste beforehand. The pre-treatment of the refuse is considerably simplified and this increases the reliability of plant operation. In all instances a good combustion of the solid refuse and of the combustion gases released in the process takes place in the installation. The combustion gases are delivered at about 950°C to a multistage oven where the mud is dried and burned independently. The combustion gases from the solid refuse burning oven and from the mud combustion are used for mud drying in the upper levels. The mud is drained using centrifuges at this facility although this would not be used in normal situations. The refuse combustion installation in Dordrecht consists of three units with a total yearly capacity of 90,000 long tons. The initial capacity is 60,000 long tons/yr and only one of the ovens is presently necessary for the mud processing. The water purification plant will have to process initially about 130,000 equivalent-inhabitant units so that the amount of mud containing a dry matter content of about 15% is about 20,000 m^3/yr. In my opinion, a disadvantage is that in each of the combinations mentioned and to some degree or other there has to be direct contact between the flue gas and the mud below a temperature of about 750°C; odourous matter, consisting of organic sulphur and nitrogen compounds in the mud, will be in the flue gas and they will not be completely burned. To remove the odour emission from the chimney a wet gas cleansing will be

The Combined Combustion of Household Refuse with Purification Mud Combustion and Gas Water (Dordrecht system)

Figuur 13

Figure 13

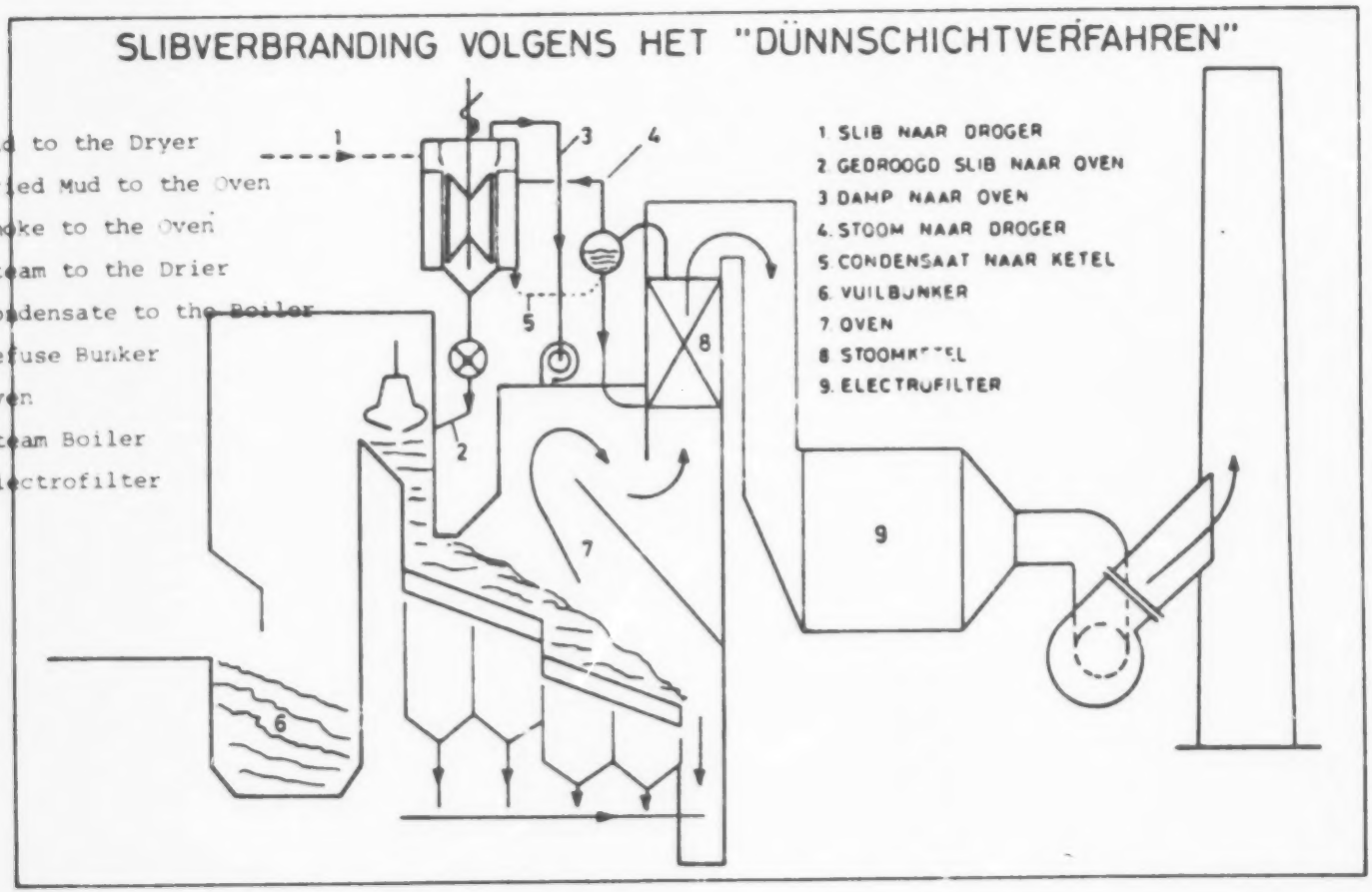


1. Bunker
2. Oven
3. Multi-stage oven
4. Gas Water
5. Mud Intake
6. Ash Outflow
7. Effluent
8. Effluent Returning Line

necessary at a temperature of 50°C or lower, certainly for the larger installations. Because of the operation below the dew point there will be a tendency that a strongly corrosive environment will exist in the gas cleanser and in the flue gas conducting units; this will require the use of very expensive materials if the plant is to be reliable. Measures can be taken to counteract the acidic environment in the cooler by using basic chemicals. Such a working procedure is envisaged for the installation in Dordrecht. In my opinion another principal, but just as expensive, solution for using, as much as possible, the heat in the flue gas, is the application of an indirect heat exchanger. In it the flue gases from the refuse combustion do not go directly to the mud to be dried but via a heat exchanger. This is a familiar system in which wet mud is conducted in a thin film along a wall which is heated by steam in such a way that it attains a dry matter content of 40-50% (the so-called thin film process -- Dünnschichtverfahren) (figure 14). The vapours produced in the evaporation process are sent into the hearth of the combustion installation so that no odours can escape to the outside. In this system the dry mud is sent as a fine granular product, together with the solid refuse, to the hearth for a combined combustion. According to the experience in Pierre (France) it is possible to process equivalent amounts of wet mud with a dry matter content of 5% with solid refuse which has a high calorific value; if this is done with fermented mud, twice the amount of mud can be processed. As far as the economic application of this last combination is concerned, the manufacturer, who supplies mud processing installations with thermal and with cross filtering using the Porteous process, suggests that one not look at installations which have a capacity higher than 7.5 m^3/hr of the mud. This means that for conditions in the Netherlands that this method would be interesting for co-operatives containing less than 150,000 inhabitants. In that case about 50,000 long tons of solid waste (about 1800 kcal/kg) could be processes per year in combination with about 45,000 m^3 of wet mud with a dry matter content of 4%.

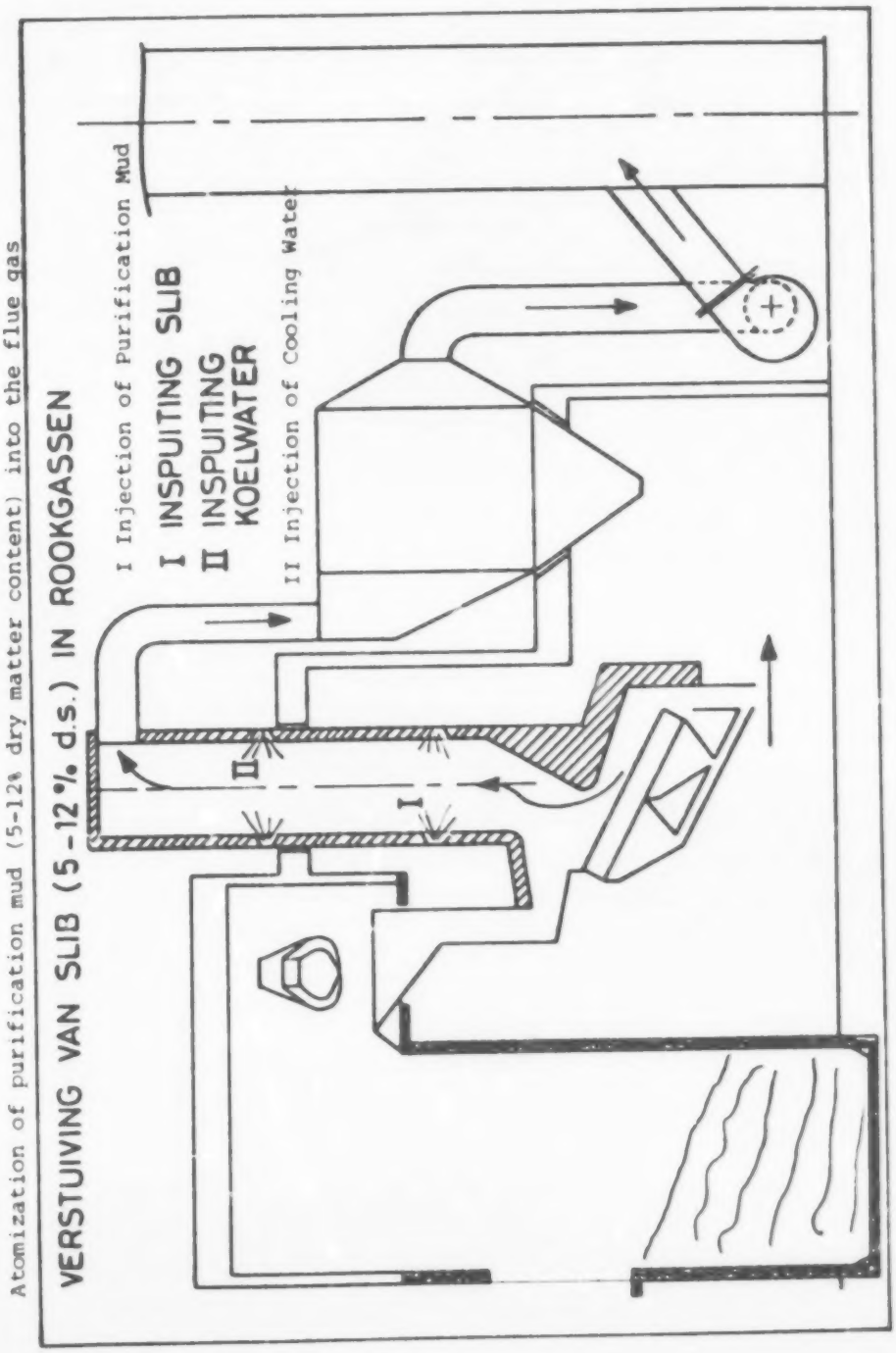
A method which is being experimented with at a number of refuse combustion installations is the atomization of liquid mud into the flue gases of the combustion installation (figure 15). As has been said earlier these gases, after having left the combustion volume, must be cooled from about 950°C to 300°C. The most modern and cheapest cooling method is that in which water is atomized into the flue gas. The water evaporates and removes heat in that way from the flue gas. For refuse which has a fueling value of 1800 kcal/kg one requires about 1.7 m^3 of water per ton of fuel. If wet mud is used instead of water, then the solid, dissolved and volatile matter in the mud will also enter the flue gas. As long as the flue gas has a sufficiently high temperature and its time of interaction is long enough then all organic matter

Purification Mud Combustion using the "Thin Layer Process"



Figuur 14

Figure 14


VERSTUIVING VAN SLIB (5-12 % d.s.) IN ROOKGASSEN
Atomization of purification mud (5-12% dry matter content) into the flue gas
I INSPUITING SLIB
II INSPUITING KOELWATER
I Injection of Purification Mud
II Injection of Cooling Water
I
II

Figuur 15 Figure 15

will be turned into CO_2 and water. Odourous matter such as organic sulphur and nitrogen compounds will be broken down there. If the gas [illegible]oled below the odour boundary, then volatile, odourous matter will be combusted to a lesser degree with the result that, for the processing of mud above a certain amount, this method will lead to difficulties in the environmental hygienic sense. If it is assumed that the cooling of the flue gas is done using mud atomization in the temperature range 950°C to 750°C and that below 750°C cooling is done by the use of pure water, then only about 0.5 long tons of mud (5% dry matter) can be processed per long ton of solid refuse. This method does not offer a complete solution. According to the literature (3), experiments have led to higher results at an installation in Derby (England). There the flue gas was cooled with mud to about 400°C. It appears to me that it is improbable that this method is usable on a practical scale without failing to meet the listed requirements which must be met for the combustion of solid refuse.

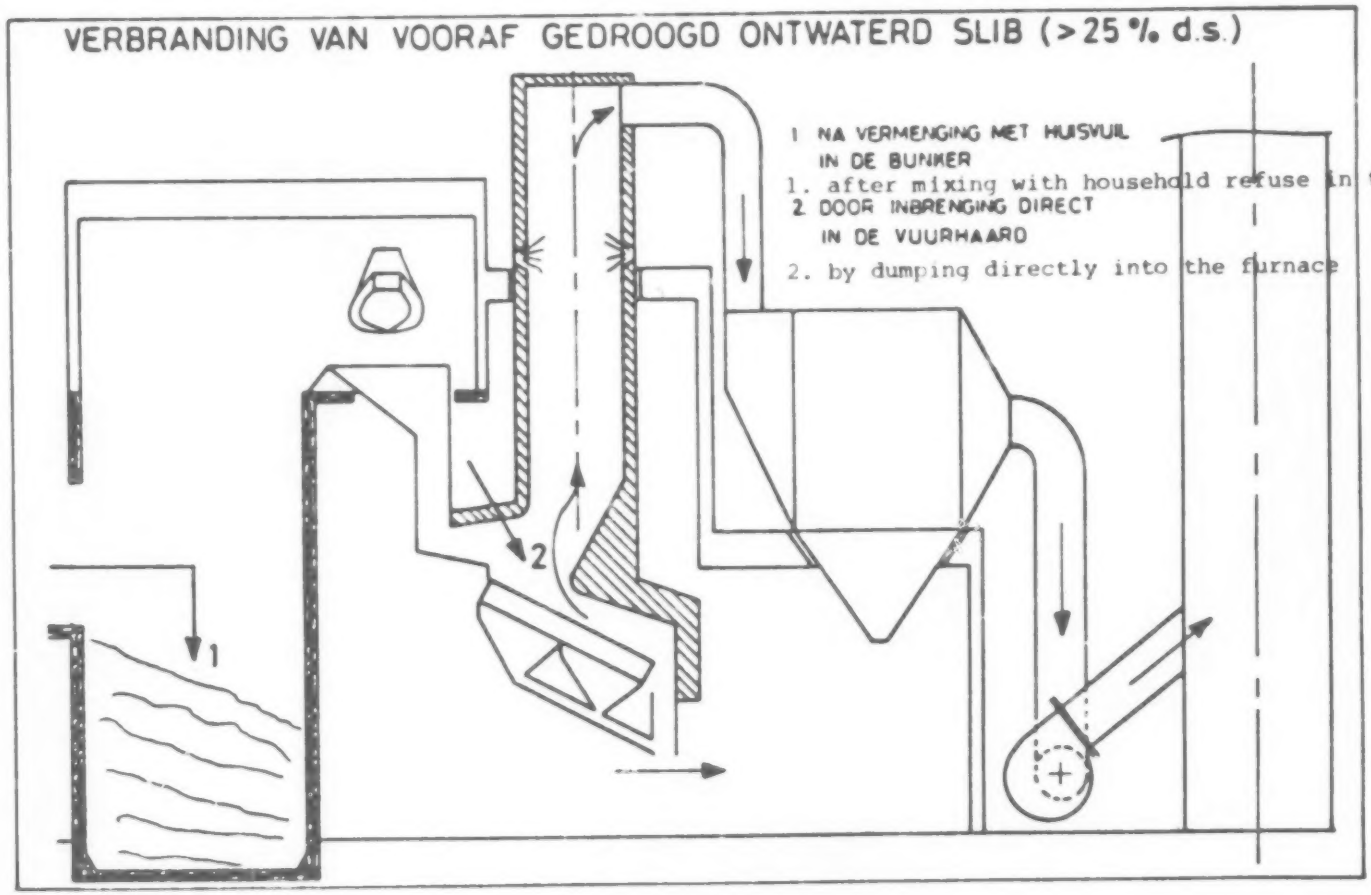
b.

A completely different method for mud processing in combination with refuse combustion is that in which the mud is drained in some mechanical way, in advance, until it has such a humidity content that it can be burned along with solid refuse in the same hearth. In principle there are two ways in which the pre-drained mud could be added (see figure 16):

1. the mud is mixed with solid refuse in the bunker.
2. the mud is brought into the oven using a special dosing facility.

In both cases the mud in not thermally dried in advance by using the heat produced in the combustion. The flue gas temperature stays above the odour boundary (at 800-1000°C). In order to obtain a good combustion in this case, a preliminary draining of the mud is necessary (e.g. with centrifuges or filters). Tests in Rotterdam and Amsterdam at the Martin refuse combustion ovens have shown that an amount of 15-20% of mud with a 20-30% dry matter content can be burned along with solid refuse without difficulty and without having to decrease the amount of solid refuse. A condition on the success of this working method is that the mixture of solid refuse is homogeneous. If this has to be done with a scooping device, then the result leaves something to be desired. If the mixing is not good then the result can be that the mud enters the oven in large chunks. The outer surface of these pieces will be burned while the interior remains unchanged. The time in the oven in that case is too short for a complete combustion of the mud when in this form. A better result can be expected if the mud is put onto the fuel bed using a throwing stoker and if it is spread over the grate in a finely distributed state.

The Combustion of previously dried and de-watered purification mud (> 25% dry matter content)


VERBRANDING VAN VOORAF GEDROOGD ONTWATERD SLIB (>25 % d.s.)
1 NA VERMENGING MET HUISVUIL IN DE BUNKER
1. after mixing with household refuse in the bunker
2 DOOR INBRENGING DIRECT IN DE VUURHAARD
2. by dumping directly into the furnace
1
2

Figuur 16 Figure 16

The limitations on the combustion of mud with solid refuse in a refuse combustion oven is not so much the high water content, which reduces its calorific value, as in the difficulty in handling, the poor transmission for gases and the long combustion time in comparison with solid refuse. For grating ovens, where the spaces between the grates are large and the wind pressure below is low, uncombusted waste can fall through. Starting from successful tests mentioned earlier it might be possible in certain cases to burn mud with a low matter content of 25% with solid refuse in a ratio of 1:5. This ratio almost is in accordance with the ratio of mud:refuse produced by the equivalent-inhabitant. Before deciding on the type of mud/solid refuse combination it is of great importance that the alternative of "mud combustion in an oven specially developed for mud" is considered. If the two alternatives do not differ much in the financial-economic sense then I am of the opinion that the preference should go to the separate mud oven. The application of the various types of oven, such as the fluidization bed oven, the multi-stage oven as well as the various types of cylindrical oven which, depending on the humidity content, can be (or not be) fuelled with oil or gas, I will assume is familiar.

Conclusions.

1. If no positive application can be given to purification mud in the agricultural sense, then one must consider whether or not the mud can be disposed of as refuse in combination (or not) with other kinds of refuse.
2. In a certain degree the problems associated with mud disposal are the same as those for solid waste disposal and it is therefore meaningful to study the methods of processing these together as well as the method of bringing it into application.
3. Research in the Netherlands on the combined compost preparation from urban refuse and purification mud has led to the following conclusions:
   a. in order to attain the 55% humidity content necessary for an optimal composting one can add wet mud instead of water. In this way about 30% of the total amount of fresh mud (not including industrial mud) can be processed.
   b. if one starts with a mud with a dry matter content of 15-20% then a mixture of mud and urban refuse in the weight ratio of 1 part of solid refuse: 1 part of mud will not lead to any difficulties. This is also true for unpulverized urban refuse as well.

4. Mud processing in combination with controlled dumping of urban refuse from the same number of inhabitant-units will not produce good results if the mud has not been sufficiently pre-drained (30-40% dry matter). To a certain degree wet mud can be processed with urban refuse. It makes a definite difference whether one uses, for this combination, the so-called rotten-dump method (Potte-Derenie) or not. If it is not used then one must count on a greater amount of percolation water. By using the rotten-dump principle it is possible to process solid refuse and mud in the same ratio as for the composting method. The amount of mud that can be added increases as the humidity content of the solid refuse decreases and as the homogeneity of the mixture increases. One can increase the homogeneity by pulverizing.
5. The combustion method can be a general solution for the combined processing of equivalent amounts of fresh wet mud and solid refuse if the total heat in the flue gases from the combustion process is used (by cooling from about 950°C to about 300°C). A reliable solution in this case however is very expensive and there is a question of whether the combined system has economic advantages over an independent draining of the mud by some other procedure at the purification plant (and then of the combustion of the mud); one could then burn the solid refuse independently as well.
6. The admixture of liquid mud into the hearth of a refuse combustion installation is only possible to a limited degree without having detrimental effects on the combustion process (especially in the combusting of the gases).
7. The combustion of pre-drained mud in combination with solid refuse in a normal refuse combustion facility is only possible to a limited degree. If one uses a mud with a dry matter content of about 25% then the tests in Rotterdam and Amsterdam indicate that one can use 1 part of mud to 5 parts of solid refuse without difficulty. A good mixing is necessary.

Literature

1. The drying of mud by biological self-heating (composting), Ir. T. Teerstra [illegible] number 10. (in Dutch)
2. The significance of the Rotter Dump for an hygienic non-objectionable disposal of purification mud in combination with solid household refuse, 1970 Abfallwirtschaft (Urban hygiene) volume 1. (in German).
3. Experiments at the facility in Derby (England).

At the moment there is no inventory of the controlled dumps available. It is not even possible to determine whether or not a dump is controlled since many of the requirements on controlled dumping are not being followed.

BIJLAGE I Appendix I
METHODEN VAN AFVALVERWIJDERING METHODS OF WASTE REMOVAL

APPENDIX II

PUBLICATIONS

Destruction of wastes? -- reprint of an article by Ir. T. Teeuwen in January 1970, published in Essobron.

Combustion methods as a method of waste removal.

Controlled dumping of urban wastes (chiefly organic wastes, which lead to pollution in the environmental hygiene sense).

Mud drying and combustion in combination with the combustion of solid wastes.

Report on waste removal for the period 1970-2000; an overview of the present-day situation with a number of postulates for a basic plan for the Netherlands, July 1970, including a note to the Secretary of State for Social Affairs and Public Health, dated 1970 July, on a development plan for regional waste removal.

The processing of solid and liquid chemical wastes and a description of the research.

Waste removal in the Netherlands, Ir. T. Teeuwen.

Waste containerization for waste removal, Ir. J. A. van der Kuil.

Note on legislative measures in the field of waste removal.

"Paper Separation" Drive in Zaandam.

Research at the Delden test dump (of the Public Body for Waste Removal in Twente (OLVT) Openbaar Lichaam Vuilverwijdering Twente) - report to the end of 1973, part V.

A three-part lecture series:
a. removal and re-cycling of wastes.
b. removal of chemical wastes that are difficult to process.
c. combustion of chemical wastes.

Composting as a method of waste removal.

Combined processing of purification mud and solid wastes.

Re-cycling of wastes.

Results of the sorting tests.

A few important aspects of the Hydrasposal system.

The controlled dump in the municipality of Ambt-Delden.

Test of the Collection of Sorted Paper by Retailers.

A few aspects of the use of plastic/paper household garbage bags.

Investigation on wastes which are difficult to process (chiefly chemical wastes).

Investigation on the usability of a bag constructed from flax for storing, collecting and processing household refuse.

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Re-cycling of glass containers.

Removal and re-cycling of waste in the Netherlands and the role of the SVA (the Institute for Waste Removal).

Note on the motivation for the drage act on Packaging Materials (Wet Verpakkingsmiddelen).

Disposal and utilization of solid wastes in the Netherlands and the role of the Institute for Waste Disposal. by Ir. T. Teeuwen, director of the Institute for Waste Disposal (the Netherlands). (in English)

16 mm film, "The Dark Side of Abundance (Schattenseite des Überflusses) -- in German" length 18 minutes, rental f 20.- per day not including shipping.